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THE
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SUMMARY of DEATHS caused by the aforesaid ACCIDENTS in and about the COAL MINES of GREAT BRITAIN during the Year 1868.

NAMES OF DISTRICTS.	Explosions of Fire Damp.	Falls in Mine.			In Shafts.									Miscellaneous Underground.									On Surface.				Gross Totals.
		Falls of Coal.	Falls of Roof.	Total Falls in Mine.	Overwinding.	Ropes and Chains breaking.	Whilst ascending or descending.	Falling into Shaft from Surface.	Things falling from Surface.	Falling from part way down.	Things falling from part way down.	Miscellaneous in Shafts.	Total in Shafts.	Explosions of Gunpowder.	Suffocation by Gases.	Irruptions of Water.	Falling into Water.	On Inclined Planes.	By Trams and Tubs.	By Machinery Underground.	Sundries Underground.	Total { Miscellaneous Underground.	By Machinery on Surface.	Boilers bursting.	Miscellaneous on Surface.	Total on Surface.	
Northumberland, Cumberland, and North Durham - -	3	4	26	30	–	1	7	2	1	3	2	–	16	–	1	–	–	2	10	–	1	14	–	–	6	6	69
South Durham - -	1	2	34	36	–	–	3	1	–	3	–	3	10	–	–	–	–	7	15	3	–	25	2	3	10	15	87
North and East Lancashire -	5	11	22	33	–	–	1	1	–	1	3	2	8	4	1	–	–	2	8	1	–	16	1	–	2	3	65
West Lancashire and North Wales - - - -	116	11	51	62	1	–	4	4	–	4	1	4	18	6	3	–	2	6	7	4	–	28	1	–	12	13	237
Yorkshire - - - - -	6	11	25	36	–	–	2	4	–	2	2	1	11	2	–	–	–	2	8	–	1	13	2	1	11	14	80
Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire - - - -	1	7	17	24	–	1	1	–	–	5	1	1	9	8	2	–	–	7	5	–	–	22	1	–	3	4	60
North Staffordshire, Cheshire, and Shropshire - - -	9	10	18	28	–	3	2	2	–	3	–	–	10	1	1	–	–	2	4	–	2	10	3	1	–	4	61
South Staffordshire and Worcestershire - - -	3	43	15	58	1	6	2	5	–	3	1	3	21	–	7	–	–	–	4	–	7	18	1	1	2	4	104
Monmouthshire, Gloucestershire, Somersetshire, and Devonshire - - -	1	10	34	44	2	1	1	–	–	–	1	–	5	4	1	–	–	4	1	–	–	11	–	–	1	1	61
South Wales - - - -	4	12	37	49	–	1	5	1	–	–	–	1	8	1	5	–	–	8	21	–	1	36	1	–	6	7	104
Eastern District of Scotland -	1	8	17	25	–	2	3	1	–	3	–	–	9	–	–	–	–	–	3	–	2	5	1	1	1	3	43
Western do. -	4	9	11	20	–	–	3	3	–	1	–	–	7	2	–	–	–	–	2	1	1	6	1	–	2	3	40
Total Lives Lost { in 1868 -	154	138	507	445	4	15	34	24	1	28	11	15	132	28	21	–	2	40	88	9	15	204	14	7	56	77	1011
Total Lives Lost { in 1867 -	286	147	302	449	22	15	51	33	8	17	4	8	158	31	16	7	3	51	78	5	25	211	14	8	64	86	1190
Decrease, 1868 -																											179

SUMMARY of Separate FATAL ACCIDENTS in and about the INSPECTED IRONSTONE MINES of GREAT BRITAIN during the Year 1868.

Names of Districts.		Falls in Mine.			In Shafts.									Miscellaneous Underground.									On Surface.				
	Explosions of Fire Damp.	Falls of Ironstone.	Falls of Roof.	Total Falls in Mine.	Overwinding.	Ropes and Chains breaking.	Whilst ascending or descending.	Falling into Shaft from Surface.	Things falling from Surface.	Falling from part way down.	Things falling from part way down.	Miscellaneous in Shafts.	Total in Shafts.	Explosions of Gunpowder.	Suffocation by Gases.	Irruptions of Water.	Falling into Water.	On Inclined Planes.	By Trams and Tubs.	By Machinery Underground.	Sundries Underground.	Total { Miscellaneous Underground.	By Machinery on Surface.	Boilers bursting.	Miscellaneous on Surface.	Total on Surface.	Gross Totals.
Northumberland, Cumberland, and North Durham	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
South Durham	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
North and East Lancashire	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Lancashire and North Wales	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yorkshire	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire	–	–	2	2	1	–	1	1	1	–	–	–	4	–	–	–	–	–	–	–	1	1	–	–	–	–	7
North Staffordshire, Cheshire, and Shropshire	2	4	6	10	–	–	3	–	–	1	–	–	4	1	–	–	–	1	1	–	1	4	–	–	1	1	21
South Staffordshire and Worcestershire	–	6	–	6	–	–	1	–	1	–	–	1	3	–	–	–	–	–	–	–	1	1	1	–	–	1	11
Monmouthshire, Gloucestershire, Somersetshire, and Devonshire	–	–	13	13	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	–	3	–	–	–	–	16
South Wales	–	1	5	6	–	–	–	2	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	8
Eastern District of Scotland	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1
Western do.	–	1	1	2	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	1	–	–	–	–	4
Total Separate Fatal Accidents in 1868	2	12	27	39	1	–	5	3	3	1	–	1	14	1	–	–	–	2	3	–	4	10	2	–	1	3	68
Total Separate Fatal Accidents in 1867	4	15	25	40	–	–	3	5	–	4	3	–	15	4	–	–	–	–	2	–	–	6	–	–	3	3	68
Decrease, 1868 -																											–

SUMMARY of DEATHS caused by the aforesaid ACCIDENTS in and about the INSPECTED IRONSTONE MINES of GREAT BRITAIN during the Year 1868.

Names of Districts.	Explosions of Fire Damp.	Falls in Mine.			In Shafts.									Miscellaneous Underground.									On Surface.				Gross Totals.
		Falls of Ironstone.	Falls of Roof.	Total Falls in Mine.	Overwinding.	Ropes and Chains breaking.	Whilst ascending or descending.	Falling into Shaft from Surface.	Things falling from Surface.	Falling from part way down.	Things falling from part way down.	Miscellaneous in Shafts.	Total in Shafts.	Explosions of Gunpowder.	Suffocation by Gases.	Irruptions of Water.	Falling into Water.	On Inclined Planes.	By Trams and Tubs.	By Machinery Underground.	Sundries Underground.	Total { Miscellaneous Underground.	By Machinery on Surface.	Boilers bursting.	Miscellaneous on Surface.	Total on Surface.	
Northumberland, Cumberland, and North Durham	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
South Durham	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
North and East Lancashire	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
West Lancashire and North Wales	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yorkshire	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire	–	–	2	2	1	–	1	1	1	–	–	–	4	–	–	–	–	–	–	–	1	1	–	–	–	–	7
North Staffordshire, Cheshire, and Shropshire	2	4	6	10	–	–	3	–	–	1	–	–	4	2	–	–	–	1	1	–	1	5	–	–	1	1	22
South Staffordshire and Worcestershire	–	6	–	6	–	–	1	–	1	–	–	1	3	–	–	–	–	–	–	–	1	1	1	–	–	1	11
Monmouthshire, Gloucestershire, Somersetshire, and Devonshire	–	–	13	13	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	–	3	–	–	–	–	16
South Wales	–	1	5	6	–	–	–	2	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	8
Eastern District of Scotland	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1
Western do.	–	1	1	2	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	1	–	–	–	–	4
Total Lives Lost { in 1868	2	12	27	39	1	–	5	3	3	1	–	1	14	2	–	–	–	2	3	–	4	11	2	–	1	3	69
Total Lives Lost { in 1867	4	16	25	41	–	–	4	5	–	4	3	–	16	4	–	–	–	–	2	–	–	6	–	–	3	3	70
																										Decrease, 1868 -	1

Mr. Atkinson's Report.

REPORT on the INSPECTION of MINES in the SOUTH DURHAM INSPECTION DISTRICT, from the 31st December 1867 to the 31st December 1868.—By JOHN J. ATKINSON, Esq.

SIR, Chilton Moor, Fence Houses, 28th February 1869.

I have the honour, as Inspector of Mines for the South Durham Mines Inspection District, to report to you, with reference to the operation of the Mines Inspection Acts during the year ending 31st December 1868.

The following Table shows the number of fatal accidents of different kinds, and the number of deaths that have resulted from them, in, at, and about the mines of the district, in each of the years 1864, 1865, 1866, 1867, and 1868; the last being the year embraced by this Report.

	Number of Separate Accidents.					Number of Deaths resulting.				
	Year.					Year.				
	1864.	1865.	1866.	1867.	1868.	1864.	1865.	1866.	1867.	1868.
EXPLOSIONS OF FIRE-DAMP -	2	2	2	1	1	3	4	28	1	1
FALLS OF COAL AND STONE.										
Falls of coal - - - - -	–	1	1	3	2	–	1	1	3	2
Falls of stone - - - - -	30	20	22	25	33	30	21	22	26	34
Total falls in mine -	30	21	23	28	35	30	22	23	29	36
IN SHAFTS.										
Overwinding - - - - -	–	–	–	–	–	–	–	–	–	–
Ropes or chains breaking - -	–	1	–	1	–	–	1	–	1	–
Whilst ascending or descending -	–	5	3	1	3	–	5	3	1	3
Falling into shaft from top - -	3	2	–	–	1	3	2	–	–	1
Things falling from top of shaft -	2	–	2	–	–	2	–	3	–	–
Falling from part way down -	5	–	–	–	3	6	–	–	–	3
Things falling from part way down	–	–	2	–	–	–	–	2	–	–
Sundries in shafts - - - -	5	2	4	–	3	5	2	4	–	3
Totals in shafts - -	15	10	11	2	10	16	10	12	2	10
MISCELLANEOUS UNDERGROUND.										
Explosions of gunpowder - -	–	2	1	–	–	–	2	1	–	–
Suffocation by gases - - - -	–	–	–	1	–	–	–	–	1	–
Irruptions of water - - - -	–	–	–	–	–	–	–	–	–	–
Falling into water - - -	–	–	–	–	–	–	–	–	–	–
On incline and engine planes -	5	9	11	11	7	5	9	15	11	7
By trams or tubs underground -	16	7	19	14	15	16	7	19	14	15
By machinery do. - -	2	1	1	–	3	2	1	1	–	3
Sundries underground - -	1	3	4	1	–	1	6	4	1	–
Total miscellaneous underground	24	22	36	27	25	24	25	40	27	25
Total underground - - -	71	55	72	58	71	73	61	103	59	72
ON SURFACE.										
By machinery on surface - -	3	4	1	3	1	3	4	1	3	2
By boilers bursting on surface -	2	–	1	2	2	6	–	1	4	3
By sundries on surface - -	7	17	10	11	10	7	17	10	11	10
Total on surface - -	12	21	12	16	13	16	21	12	18	15
GROSS TOTALS -	83	76	84	74	84	89	82	115	77	87

There are very few ironstone mines under the operation of the Mines Inspection Act in this district, and it is gratifying to have to report that no fatal accident has occurred in connexion with them during the past year, 1868.

It may be observed from the preceding tabular statement that only one death has taken place during the past year from the explosion of fire-damp in the district; this, too, is a comparatively satisfactory result; and when it is considered that a greater quantity of coal is raised in this than is raised in any other district, and that many of the seams of coal in it are of a fiery character, while, from the great engineering difficulties and the great expenses attending the sinking of shafts in the eastern part of the district, very large areas of coal are worked by each colliery, involving, of course, proportionally great preparations and outlay to produce proper ventilation at long distances from the shafts, such a result, in my opinion, reflects very great credit upon the owners and managers of the mines of the district; a result only atttainable by very great care and liberality of outlay, and a rigid enforcement of discipline amongst the work people; and the same result naturally reflects a degree of credit upon the men and boys, who so generally submit to the discipline imposed upon them, notwithstanding the exceptions to the rule.

The number of deaths caused by falls of coal and of stone in the district has been greater than usual during the past year, thirty-six persons having been killed, through thirty-five accidents, one of which, a fall of stone in the broken or pillar workings at Brancepeth Colliery caused the deaths of two persons, both of whom were coal hewers. The average number of deaths from this class of accidents during the preceding four years (embraced by the table) was only twenty-six, the increase beyond this number during the past year being nearly thirty-eight and a half per cent.

It is difficult to assign any truly satisfactory reason for the great yearly variations in the yearly number of deaths caused by this particular class of accidents; but I imagine that sudden changes in the state of the atmosphere as to pressure, moisture or dryness, and as to temperature, has more or less influence upon the strata forming the roofs of working places and roads, and may, to some extent, account for them; falls of roof being apt to occur from sudden changes in the state of the atmosphere.

In my last annual report I only had to allude to two deaths as having been caused by shaft accidents during the previous year, 1867, compared with an average number of 13 deaths per year during the four preceding years, and in that report I ventured to express a hope that, for reasons assigned, some considerable reduction in the amount of fatality from this class of accidents might be permanently maintained.

I regret to have to state that during the past year, 1868, ten persons have lost their lives through shaft accidents, which is just equal to the average loss of life from the same class of accidents during the preceding four years that are embraced by the tabular statement.

During the year 1868, accidents of a miscellaneous character (but consisting chiefly of crushes by coal tubs) in the mines of the district caused the deaths of twenty-five persons, each by a separate accident, 29 being the average of the preceding 4 years.

On the whole the deaths that have resulted from underground accidents in the mines of the district during the past year have been 72 in number, compared with an average number of 74 per year during the preceding four years which are included in the tabular statement.

The deaths that have been caused by accidents on the surface, at and about the mines of the district, during the past year, have been 15 in number, whereas on the average of the four preceding years embraced by the table, the number was nearly 17; the reduction being but slight.

On the whole (inclusive of deaths caused by both under-ground and above-ground accidents, in, at, and about the mines of the district) the number during the past year has amounted to 87, whereas on the average of the four preceding years the number per year was 90¾, so that altogether this gives a reduction of upwards of four per cent. in the number of deaths as compared with the preceding four years included in the table.

During the past year three of the accidents in connexion with the mines of the district have resulted in the deaths of two persons each, one of such accidents being a fall of stone, another being through entanglement with machinery connected with a small coal apparatus on the surface, one of the victims in this case becoming entangled while he was endeavouring to rescue the other; this took place at Framwellgate Colliery in March 1868. The third accident which caused the deaths of two persons happened at Kelloe Winning, through the bursting of a boiler there. The whole of the other accidents at the mines of the district in the year 1868 each resulted in the death of a single person only.

A detailed list of the fatal accidents and of the deaths that have resulted from them during the past year 1868 is appended to this report, and prefixed to it are summaries in which the fatal accidents, and the deaths resulting from them, are classified, both as regards the coal mines, and separately as regards the ironstone mines coming within the scope of the Mines Inspection Act, in each of the twelve inspection districts into which Great Britain is divided.

There is also prefixed to this report a return showing separately for each of the twelve inspection districts into which Great Britain is divided the number of male persons employed in, at, and about the coal mines, the quantity of coal raised, the number of fatal accidents, and the number of deaths that have resulted from such accidents; and also the number of persons employed per fatal accident, the number of persons employed per life lost, the tons of coal raised per fatal accident and per life lost through such accidents, and the number of collieries.

The following comparative statement is extracted from the last-mentioned return.

1868.	The whole of Great Britain.	The South Durham Inspection District.
Computed number of persons employed ; on census basis	346,820	37,000
Computed quantity of coal raised, in tons	104,566,959	15,300,000
Number of fatal accidents	860	84
Number of lives lost by such accidents	1,011	87
Number of persons employed per fatal accident	403	440
Number of persons employed per life lost by fatal accident	343	425
Tons of coals raised per separate fatal accident	121,589	182,142
Tons of coals raised per life lost by accidents	103,429	175,862
Number of collieries in the district	3,291	171

Fatal Explosion of Fire-damp.

As happened in 1867, and as was mentioned in my report of last year, I may here repeat with respect to the year 1868, that only one explosion of fire-damp in the mines of the distriet during the past year has proved fatal to life, and even in this solitary case no other person than the unfortunate victim, Joseph Palmer, an onsetter, twenty-three years of age, was injured by it.

It occurred on the 7th August 1868, at the new pit at Thrislington Colliery, the shaft of which had only a short time previously been sunk from the surface down to the Harvey seam of coal. A furnace had been placed on the surface, close to the top of the shaft, for the purpose of ventilation, while the shaft holings and other preliminary operations were being carried out before commencing the ordinary working of coal. The surface furnace was surmounted by a chimney. In one direction in the mine a considerable amount of fire-damp had been given off (south-westwards from the shaft), where the rising of the seam of coal was at the rate of about six inches in the yard, and of necessity had to be ventilated by means of brattice; but this had been driven so as to open a communication between the two compartments (downcast and upcast) of the shaft, about three weeks before the explosion took place.

After the completion of this communication between the down-cast and the up-cast divisions of the shaft the sinkers had been employed in putting guides into the shaft, and raising the water from the sump at the shaft bottom.

About ten o'clock on the night of the 6th August some permanent brattice was substituted for the temporary brattice near the bottom of the shaft, which would naturally have the effect of lessening the leakage of air at that part, and of causing a stronger current to pass through the few workings in the seam of coal.

The onsetter Palmer went, as usual, to guide the water tub, near the sump, at the bottom of the shaft, and he was the only man in the mine at the time when the explosion took place.

A deputy overman examined the workings at ten P. M., and reported to the master sinker, in the presence of Palmer (but not to the overman), that he had observed fire-damp resting in a wedge shape up the south-west holing. About 1. 15. A. M. on the following morning (the 7th August) the banksman observed a flash of flame come out of the furnace chimney, and a few seconds afterwards he heard an explosion in the up-cast shaft, which proved to have blown out a considerable quantity of the brattice separating the down-cast from the up-cast compartments of the shaft. The onsetter was employed at the bottom of the down-cast division of the shaft, and had no naked light, but only a safety lamp; so that the explosion almost certainly originated at the ventilating furnace on the surface.

I may here mention that I had previously obtained a promise from Mr. Wood the manager that he would open out the seam of coal with safety lamps only, notwithstanding his stating to me at the time that the seam was, so far, very free from fire-damp, and that I was not aware of a furnace having been adopted to ventilate the mine until I received notice of the explosion having occurred.

When the top of the fallen brattice and of other materials was reached at the lower part of the shaft, on the 8th August after the explosion, the onsetter was found sitting upon it, not burnt but quite dead, probably from suffocation by the after-damp resulting from the explosion.

At the inquest Mr. Wood the manager stated that he had adopted the furnace as a temporary means of producing ventilation, thinking it safe to do so as no fire-damp had then been observed.

That a feeder of fire-damp was, however, encountered after driving about 50 yards to the rise of the seam.

That the workings of the mine might become foul during the time the workmen were replacing the temporary brattice by the permanent brattice near the bottom of the shaft, and that the extra pressure of air laid upon the workings after substituting the permanent for the temporary brattice might have the effect of bringing off any previous accumulation of fire-damp, and that this might be ignited at the furnace at the top of the shaft and so cause the explosion.

Under the circumstances he stated that he thought that Raisbeck, the overman, who resides at the colliery and had charge of it in his absence, ought to have watched with a safety lamp the state of the return air near the shaft; and that if he had found it to be explosive he ought to have had it diluted with fresh air, by opening a door separating it from the intake fresh air, so as to have prevented an explosive current from ascending the shaft and reaching the furnace there.

Mr. Wood did not reside at the place and was not aware of the hourly changes and operations going on at this particular colliery, he having the charge of several others.

Similar views to the above were given by Mr. Armstrong of Wingate, and by Mr. Joseph Smith, in their evidence, both being managers of neighbouring collieries.

John Scarth, a chargeman over sinkers, Richard Brown, a banksman, and Matthew Raisbeck, an overman, were each examined at the inquest.

In this case I think that Matthew Raisbeck showed a want of judgment in not watching, or sending some one to watch, the state of the return air near the bottom of the shaft, while the replacing of the temporary brattice by permanent brattice at the shaft bottom was in progress; and, if I mistake not, the deceased onsetter, Joseph Palmer, was his son-in-law. I also consider that it was imprudent, under the circumstances, to have employed a furnace, even on the surface, to produce ventilation; and that a waterfall in the downcast shaft, or, in its absence, a small ventilating fan or air pump, ought to have been employed for the purpose of opening out the mine.

The jury after hearing all the evidence returned a verdict of accidental death.

Falls of Coal and Roof.

In the coal mines of the district, during the past year, two deaths have resulted from falls of coal, and thirty-four from falls of stone and roof, making a total of thirty-six deaths from this class of accidents.

The occupations of the victims were as follows:—

By falls of stone and roof:		
Coal hewers	23	
Deputies	5	
Putters	4	
Shifter	1	
Stone workman	1	
	—	34
By falls of coal:		
Coal hewers		2
	Total	36

Although this amount of fatality from falls of stone and coal is considerably greater than the average amount for this district during the twelve years ending 31st December 1867 (see page 3 of my last annual report,) yet it was exceeded in the years 1859 and 1863, in each of which years there were forty deaths from the same class of accidents; the quantity of coal raised, however, was considerably smaller in amount upon an average of these years than it was during she past year

I have little reason to attribute the marked differences in the number of deaths caused by falls of stone and roof to any other cause than to atmospherical conditions and changes being different and more or less favourable during some years than they are during others, as, for the most part, the persons in charge are the same, and the systems of working the mines but litte altered from year to year.

Occasionally, however, it may be that from an extra demand for coal there may be an influx of unpractised workmen into the mines, resulting in an increase of this class of accidents, from the want of experience on the part of the new workmen employed.

It may be seen, by a reference to a table at page 15 in my last annual report, that the yearly proportional variations in the number of deaths caused by this class of accidents become smaller as they apply to wider areas and to a larger number of collieries, the whole of Great Britain giving much smaller proportional variations in their number from year to year, over a period of ten years embraced by the table, than are exhibited by the numbers for the South Durham district alone, during the same years in that table.

In my last annual report (page 7) I stated my opinion as to the causes of the deaths from this class of accidents having in this district during a period of twelve years been less than one half of the number, in proportion to the quantity of coal raised, than occurred in the whole of the coal mines of Great Britain.

I beg to remark upon some of the accidents from falls of coal and stone. No. 2 accident in the list occurred while the sufferer with others was engaged in setting timber to support the roof, the master shifter, who was within a few yards of the place and in charge of the work, having detected no danger.

No. 4 accident in the annexed list caused the death of a putter, who had improperly exchanged employment at the time with the hewer in whose place it occurred. The place had been examined by the overman, who had not apprehended any danger.

No. 7 accident occurred in a place which was closely timbered towards the working face; the brother-in-law of the sufferer worked in the same place, and they had no apprehension of danger previous to the accident.

No. 23 accident occurred within a few minutes after the deputy had left the place, and deceased, it appears, had complained of the deputy having put in too much timber near the face of the place, as being a hindrance to his getting worked.

No. 33 accident in the list caused me to suggest a regulation which I hope may have a tendency to prevent similar accidents, under like circumstances, in future.

No. 36 accident occurred while a deputy was in the place fixing timber for the further support of the roof.

No. 37 accident caused the death of a deputy while he was engaged in removing a prop.

No. 44, like No. 4 accident, resulted in the death of a putter, who was improperly hewing coal in lieu of attending to his own duties.

No. 53 accident caused the deaths of two coal hewers, although a deputy had examined the place, and put in timber for the support of the roof, only about ten minutes before the fall occurred, and one of the sufferers by the accident (as in No. 23 accident) had complained to the deputy of his having put in too much timber for the purpose, and during the short time that elapsed between the deputy leaving the place and the occurrence of the accident one of the sufferers was observed by a putter to be apparently in the act of removing one of the props which the deputy had just put in to support the roof, and it appears to be probable that this act caused the fatal fall of stone to take place.

No. 72 accident occurred in a place which had been visited by the overman of the pit a few hours previously, and later still by one of his deputies, who had put in additional timber for the support of the roof, and had left loose timber to be used in case of need.

No. 73 and No. 83 accidents in the list each caused the death of a deputy overman while removing timber where the roof was no longer required to be supported for the purpose of working the coal.

I may conclude my remarks on this painful subject by observing, as I have done in former reports, that the fatality arising from this class of accidents is much higher amongst the deputy overmen, who are employed to protect the lives of the ordinary workmen, than amongst the workmen themselves; the occupation of deputies is of a highly dangerous character, and I would once again urge upon them the necessity of looking to their own personal safety, at the same time that they do not neglect to attend to that of others.

Fatal Accidents in Shafts.

During the past year ten separate fatal accidents have occurred in the shafts of the coal mines of the district, each causing the death of a single person.

Although this amount of fatality is greater than I anticipated in my last report it is slightly below the average of the last ten or twelve years, and is considerably less than the average number of deaths from the same class of accidents (in proportion to the quantity of coal raised) in the whole of the mines of Great Britain.

No. 6 accident in the list consisted of the sufferer being crushed while ascending the shaft, but there was nothing to show in what manner he had received his injuries; it was an ordinary cage that he was in, no person being along with him.

No. 24 accident was the case of a workman, while descending a series of 14 ladders in a shaft by which the workmen enter and leave the mine. The deceased appears to have thought that he had reached the bottom of the shaft when he was the height of either one or two ladders' lengths above it, and so to have slipped down and rolled or fallen to the bottom of the shaft.

No. 41 accident in the list caused the death of a coal hewer, who fell out of an iron tub, in which he, along with another hewer, was being lowered from the main coal down to the low main coal seam. The tub in the first place appears to have been caught and suspended by a slightly projecting skating or guiding deal end; its descent being thus arrested some slack chain at the low end of the winding rope appears to have accumulated, and after this the tub appears to have become liberated and to have fallen away, the jerk causing the deceased to lose his hold and to fall out of the tub, and to the bottom of the shaft, causing his death.

It appears to be probable that they had not placed themselves properly in the tub, so as to balance and keep it in a vertical position, owing to which it probably was caught by the projecting end of the guiding or skating deal; the depth which the victim would fall would be about 20 fathoms.

The main coal seam, from near the level of which the deceased fell, had, until very shortly before the accident, been the lowest seam of coal that had been worked at the colliery, and as the low main coal seam at a depth of about 20 fathoms beneath it had only been sunk to a short time previously, the application of guides and cages had not, at the time of the occurrence, been introduced between the two seams, and hence the ordinary mode of ascending and descending in such cases by means of a tub was in use at the time.

No. 43 accident in the list was the case of a coal hewer, who had been engaged in driving the shaft holings within three yards of the bottom of the shaft, by some unknown means falling into the sump, a receptacle for water, being a continuation in depth of the shaft, below the seam of coal in which he was employed. The coals having all been cleared away, the onsetter removed the cover of the sump for the purpose of having the water drawn out of it, and he states that he had told the deceased of his having done so, yet he had by some means fallen through the hole into the sump, and was there drowned.

No. 48 accident in the list occurred at a self acting drop staple, and caused the death of the onsetter, who was employed at the bottom of the staple.

It appears that he had put some timber into the cage at the bottom of the staple (which is 11 fathoms in depth), and then called up to the brakesman at the top of the staple to have it drawn up, but that a part of the timber, which had projected from the cage, came into contact with some of the timber fixed in the staple, and arrested the ascent of the cage near to the bottom of the staple. The onsetter then went up ladders which were fixed in the staple, and liberated the cage which was again put into motion; but the timber in the cage, for the second time, came into contact with fixed timber, a little higher up the staple, and the onsetter again went up the ladder to liberate it, and afterwards called to the brakesman to raise the cage while he was beside it; on the cage being again put into motion it was almost directly arrested, for the third time, in its ascent, and on the brakesman coming down the ladders he found the onsetter's head jammed between one of the cross timbers fixed in the staple and the cage.

The timber put into the cage by the victim of the accident ought to have been tied so as to prevent it from projecting, and even in the absence of that ordinary precaution, with proper care he need not have lost his life, if we assume the evidence to be correct as to his ordering the cage to be raised after freeing it the second time, and I saw no reason to doubt its correctness.

No. 49 accident in the list resulted in the death of a young man who had imprudently put himself into a position of danger near the top of a shaft to call down to another person as to the meaning of some misunderstood signals, and it being night, and he not within sight of the brakesman, whom he had not told where he was going, the brakesman lowered the cage, which crushed the deceased against a fixed timber by the side of the shaft, over which his head had projected into the shaft. There was proper signalling apparatus at the shaft, and deceased ought not to have placed himself in danger to call down.

No. 63 accident caused the death of a shaftsman, who having lost a lamp off a cradle part of the way down the shaft, got himself lowered down by a clumsy arrangement, and after recovering the lamp and being drawn up again by the same means, the hook of the loop in which he was sitting lifted a cross timber in the shaft over which the rope was sliding; this timber afterwards appears to have fallen upon him, and knocked him out of the loop, and caused him to fall to the bottom of the shaft and into the sump, a distance of nearly 40 fathoms.

No 64 accident resulted in the death of a youth, who fell into the cage hole at the bottom of the shaft through his feet slipping on the smooth flat sheets; the cage came down the shaft upon him immediately, in its ordinary course, and so crushed him that he died.

No. 74 accident caused the death of a deputy overman. He was in the act of getting into a shaft cage, after two other men were in, to descend the shaft, at the time when the descent of the cage commenced, and he fell down the shaft in consequence.

The movement of the cage appears to have arisen from a mistake on the part of the engineman, who states that he heard some one call for him to lower the cage, and that he could not see the men getting into the cage. They were getting into the cage at the level of the railway branches, a practice which had been long pursued by men going down the shaft at nights, but which was contrary to the orders of the viewer, and without his knowledge. It seems probable that the engineman had mistaken the source of a call, which he states that he heard, as there were other persons within a short distance who might have called one to the other "how way," and this to the engineman, if he thought it came from the banksman, would lead him (the engineman) to think that the lowering of the cage was required.

It was on the evening of a windy November day, and steam from the adjacent boilers was calculated to obscure his view of what was going on. Orders have been repeated, and I believe fully enforced, as to men not being allowed to get into the cages at the level of the railway branches, since this accident.

No. 79 accident was caused by a small piece of timber falling from a loop whilst being drawn up a new shaft, and striking the sufferer, who was engaged at the bottom of the shaft. It would appear that the small piece of timber had been by some oversight sent away from the bottom of the shalf on the point of the hook, and that it had dropped off on coming into contact with the side of the shaft after it had been raised for some distance from the bottom.

The timber or board was used for securing building stones in being lowered down the shaft for masonry that was in progress there.

As a majority of the shaft accidents appears to have been more or less due to a want of proper care on the part of the sufferers themselves, and the others appear to have been so purely accidental, I refrain from further remarks on the subject, beyond pointing out how very careful and guarded every one ought to be while ascending or descending, or while they are employed in or about the shafts and underground staples of mines.

I have in previous reports pointed out many matters which ought to be attended to, with a view of preventing accidents in such situations.

Miscellaneous Underground Accidents.

Twenty-five accidents of this class have each caused the death of one person in the mines of the district during the past year, being slightly below the average of the preceding four years embraced by the table.

The deaths from being crushed by coal tubs on self-acting inclined and engine planes in the mines have only been seven in number during the past year, compared with an average of 10 deaths per year from the same class of accidents during the preceding four years embraced by the table.

During the past year 15 deaths have resulted from crushes by tubs on the ordinary tubways in the mines, being one more than the average number of deaths per year from the same kind of accidents during the preceding four years embraced by the table.

Three deaths have been caused by underground machinery during the past year, whereas one death per year was the average number over the preceding four years embraced by the table.

There have been no deaths during the past year from explosions of blasting powder or suffocation by gases.

The victims of this class of accidents include persons of various occupations; they stand thus for the past year,—

Rolleywaymen	2
Drivers	4
Putters	7
Hooker-on	1
Helper-up	1
Shifter	1
Sheave greaser	1
Hewers	2
Horsekeepers	2
Onsetter	1
Trapper	1
Landing boy	1
Brakesman	1
Total	25

The putters in the low and extreme part of the workings of the mines, who for the most part are engaged in driving small ponies, are the principal sufferers; and the horse drivers in the horse roads of the mines are the next in order.

I do not see any necessity for giving the details of these accidents, as they are so varied in their character and occur to so many different classes of persons and under such a variety of circumstances that it is difficult if not impossible to draw any further general conclusions as to precautions intended to avoid their occurrence in future beyond such as have from time to time been mentioned in my previous annual reports.

The crushes by tubs sometimes arise from horses taking fright, switches being wrong, putters not keeping their heads down in low parts of the mine, signalling for full tubs to be set away from the tops of inclined planes before hooking the empty ones to the rope at the bottom, wrong or misunderstood signalling, getting upon tubs while in motion, and being met or overtaken by engine trains without getting into refuge holes in time; other accidents occur from being struck by the handles of winches used for changing ropes where the engine plane roads of a mine separate, getting entangled in the machinery of underground engines, and from numerous other miscellaneous causes.

As every case of death from mine accidents is carefully inquired into before a coroner and jury, and as it seldom happens that a verdict of manslaughter is returned, and only occasionally that any censure is expressed, it may be assumed that although there is more natural danger in mines than on the surface, yet that agents and workmen in mines are not more guilty of crime, neglect, or disobedience while they are in mines than when they are on the surface; and that if these accidents are to be to any considerable extent reduced in the frequency of their occurrence it must be by improved modes of conducting the transit of coal, and of other underground operations, rather than by any considerable extension of the Acts of Parliament for the regulation and inspection of mines or of the general or special rules framed under their authority.

Aboveground Accidents.

The deaths that have resulted from accidents upon the surface at the mines of the district during the past year have been 15 in number, compared with an average number of 16¾ per year during the four preceding years embraced by the table; so that their number has been slightly below that average.

The occupations of the sufferers were of various kinds, but I may mention that four of the sufferers were employed as screenmen, and were crushed by waggons and trucks at or near to the coal screens.

In one case a boiler explosion caused the death of a single person, and in another case a boiler explosion caused the deaths of two persons.

In another case two persons were crushed by machinery employed for the purpose of separating the small coals from the dust and refuse.

Boiler Explosions.

No. 29 accident in the list arose from the explosion of a boiler, which caused the death of an engineman who was about to relieve his fellow engineman, but had not taken charge of the engine at the time when the explosion took place.

After a careful inspection of the parts of the exploded boiler I attended the inquest, when the following statements were elicited.

William Speed was the brakesman or engineman in charge at the time of the explosion; John Swinney was the colliery engineer, and had the general charge of the boilers, to see that they were sufficient and kept in proper repair, and John Porter was the foreman blacksmith who superintended the execution of such repairs.

The steam was heard to be blowing off at the safety valves immediately before the explosion took place; the deceased was found between the 3d and 4th boilers, reckoning from the engine-house; he was dead, having been injured about his brow; he had been bleeding, but was blackened when found amongst the wreck about half an hour after the explosion. Deceased had been seen going towards the boiler fire holes a few minutes before the explosion occurred.

The explosion took place about 4 A.M. on the 4th of April.

At the colliery there were 4 boilers placed side by side, numbered 1, 2, 3, and 4, respectively, No. 1 being the one next to the side of the engine house.

It was No. 2 boiler, the 2d one from the engine house, which exploded.

There were two floats and two safety valves (one $3\frac{1}{2}$ and the other $3\frac{7}{8}$ inches in diameter) in connexion with each of the boilers. Each boiler had an unplugging apparatus and a feed pipe and valve, but there was not a valve to prevent the water being thrown out of one boiler into another through the feed pipe.

The boiler was cylindrical, and had hemispherical ends; it was 28 feet in length over the ends, and was constructed of plates $\frac{3}{8}$ths of an inch in thickness, and they were found to be of nearly their primitive thickness along the lines of fracture. The boiler had been constructed by the Birtley Iron Company, the owners of the colliery, and had been in use about 29 years. The plates had cracked and had been patched in some parts. The boiler had been repaired on several occasions, but the fractures did not pass through any of the patches. A model of the boiler showing the seams, lines of fracture, and the position of the fittings was exhibited at the inquest.

The boilers were fed with water from the mine and deposit a thin hard incrustation, but they were cleaned once a month. There was nothing amiss with the feed apparatus. The water was heated before being sent into the boilers.

The most recent repairs to the boiler were made about 4 days before the explosion took place. Flash flues and external firing were employed.

The steam jug was found to have had its valve open, so that the exploded boiler would have a steam communication with the other boilers and with their safety valves at the time of the explosion.

The ordinary working pressure was 30 lbs. per square inch, and the valve weights required to be at the ends of the levers to get this pressure upon the valves. The exploded boiler was filled on the First of April after being repaired, and was boiled the next morning, and the steam raised to its working pressure. Daily sludging was practised. The feed valve was closed at the time of the explosion. The boilers were fed by a donkey engine. Some of the plates forming the boiler appeared to be crystallized, and more or less brittle and deteriorated by long use or exposure to the heated air and gases from the fire. There were no appearances to indicate that there had been any want of water in the boiler, or overheating of the plates composing it.

My opinion as to this boiler explosion is, that it occurred under the usual or ordinary working pressure at a longitudinal seam where an old crack, about 10 inches in length, was discovered (after the explosion) to have existed in the plate, but which does not appear to have been detected previous to the explosion. In pinning some of the rivet holes when repairing the boiler immediately before the explosion I think it highly probable that the plate had been further weakened at this old crack, and that to such an extent as to render the boiler incapable of sustaining the working pressure, so that it exploded as soon as the steam was got up and that pressure was brought upon it.

There appeared, from the evidence, to have been no leakage at the old crack to lead to its detection previous to the explosion, and hence it had probably not extended through the entire thickness of the plate.

No. 45 accident in the list was also a case of boiler explosion; it caused the deaths of two persons, and occurred at about 20 minutes after 7 o'clock P.M. on the 8th of June.

In this case there were 8 boilers placed side by side, and it was the 3d boiler from the eastern side of the range that exploded; No. 5 and No. 8 boilers were not being worked at the time, but the other 6 boilers were being used.

The evidence at the inquest led to the following conclusions: the boilers numbered 1, 2, 3, and 4 had their fires damped up during all the day of the explosion, had each been properly charged with water during the forenoon, and were examined and found to be all right at 5 o'clock in the afternoon, at which time the feed water was going into No. 7 boiler alone.

The steam valves of Nos. 1, 2, 3, and 4 boilers were closed at that time; the feed is supplied by a donkey engine from a pond in which there was plenty of water.

No leakage had been observed in the boiler that exploded, which had been cleaned about 8 days previous to the occurrence. The closing of the steam valves puts the boilers out of communication with the steam gauge so long as they remain in that state. There was no alarm whistle for indicating a want of water. The boilers were sludged twice a day. A considerable amount of fur was deposited by the feed water. The damper was down at 5 P.M., when John Morgan, who was one of the enginemen, left the engine.

The boilers were fired by means of Jukes' apparatus. There was an outside kep clack in connexion with the feed to prevent the backing of the water. Where Jukes' apparatus is employed a leakage cannot be seen, but may be detected by hearing the evaporation of the water.

On the 8th of May, about a month previous to the accident, about 20 rivets had been renewed in the boiler, and a length of about 8 feet of seam had then been caulked on the underside of the fire end of the boiler, and on the 29th May, when these repairs were finished, the foreman stated that he examined the boiler and observed no danger.

A model of the boiler, showing the positions of the seams and of the safety and working apparatus and those of the lines of fracture caused by the explosion, was produced at the inquest by Mr. Benjamin Dawson, the colliery engineer, together with samples of plates which had been torn by the explosion.

He stated that the boiler was built by Messrs. Hawkes and Co., and was about 27 years old, but that it had only been in actual use about 14 years, having been at Murton and at Wingate Collieries before being used at Kelloe Winning. There was no considerable thinning of the plates that had been torn by the explosion. The boiler was 30 feet in length, and 6 feet in diameter, and had upon it two safety valves, each 4 inches in diameter, and two common wheel floats, but no water-alarm whistle.

The steam gauge was not in connexion with No. 3 boiler at the time of the explosion. The steam, feed, and sludge valves were found closed after the explosion. There was no sign of want of water or of overheating on the plates of the boiler.

The water used is the limestone feeder, and forms a considerable amount of scale or fur on the boiler plates; sometimes it is $\frac{3}{16}$ths of an inch thick; the boilers were cleaned about once a fortnight or once in three weeks.

The boiler was tested by hydraulic pressure up to 70 lbs. per square inch about two years previous to the explosion.

The safety valve weights required to be at the ends of the levers to give the working pressure of 35 lbs. to the square inch.

The boilers were under the inspection of a Boiler Insurance Company, and had been last inspected by a person on behalf of the Insurance Company on the 26th May, when No. 3 boiler was at work; a few small leakages were then observed in it over the fire, and the caulking was afterwards done in consequence.

In this instance, I am of opinion that the boiler had a proper supply of water in it, that the safety attachments were in proper working order, and that the explosion took place either at the ordinary working pressure or at the usual very slight extra pressure arising from the resistance of the safety valves to the steam in blowing off.

I think that the tearing of the boiler had originated at an old crack, about 15 inches in length, which appeared to have extended in a longitudinal direction along the boiler, but had not been detected until after the explosion occurred. After the boiler had exploded, and until this old crack was discovered, I had thought that there must have been some unusual amount of pressure to cause the boiler to explode, but when it was found I changed my opinion as to the cause. When once a considerable rent is made in a boiler the pressure acting upon the plates adjacent to the line of separation is generally sufficient to tear the boiler to pieces, even through the strongest parts of the solid plates of which it may be composed.

It may be observed that I attribute these two boiler explosions to precisely similar causes, that of an old crack in the plates which had escaped detection ; but it is evident that in old boilers which have long been in use, and have had the plates partially crystallized and deteriorated, and have frequently been repaired, and strained more or less by pinning the rivet holes so as to bring them together, such cracks are more likely to exist than in newer boilers that have been less subject to such strains.

And hence upon the whole I should consider that an increased amount of freedom from these unpleasant occurrences would result from limiting the age and the time during which boilers should be allowed to be used, together with enforcing the testing of boilers by hydraulic or pneumatic pressure up to about twice the pressure at which they should be allowed to be worked at moderate intervals of time.

No. 46 accident in the list arose through an engineman improperly asking a youth of only 12 years of age to put a driving belt to the centre of a sheave, when he ought to have done it himself, as he was at the time in charge of the engine and of the machinery.

The youth, in attempting to put the driving belt into its proper place, became entangled with the adjoining spur wheels, and received such injuries as caused his death; and the engineman in attempting to rescue him fell, and came in contact with the arms of the fly-wheel, and also received injuries which almost immediately caused his death. The engine had only been at work a few days at the time, and was used for the purpose of working a small coal apparatus. Although the youth had nothing to do in the engine house (he being employed to grease sheaves upon the railway), yet the engineman ought neither to have allowed him to be there, nor to have asked him to place the driving belt in its proper position upon the sheave.

Reported non-fatal Accidents.

A number of non-fatal accidents, causing more or less personal injury, have been reported as occurring during the past year; but it would appear to be altogether useless to attempt to classify or marshal the figures or statistics, as there is such a very wide discrepancy between the degrees of injury that have been caused by them; and I have good reason to think that whilst accidents of this nature, causing very slight and temporary personal injuries, are reported from some collieries, others causing permanent personal injuries are not reported from other collieries.

I may however select a few for remarking upon.

One of the non-fatal accidents was an explosion of a small quantity of fire-damp at Thornley Colliery, in which I consider that there was a want of proper precaution both on the part of the overman and on that of one of his deputies.

The overman had cautioned the sufferer to use a safety lamp when holing his board into a wall lest there should be fire-damp in it, there being a small dislocation of the strata in the wall. On effecting a holing into the wall the hewer called the deputy overman, who, on opening the place, gave him leave to work with a naked light, and to blast; but a slight explosion of gas arose from his blasting by which he was scorched.

The hewer ought not to have been allowed any discretion in the matter, but should have had a safety lamp given to him and been prohibited from using a naked light as well as from blasting under such circumstances.

The overman's cautions were short of what they ought to have been, and the deputy and hewer were both to blame for not obeying them; besides which there is reason to fear that the deputy had not made a sufficiently careful examination of the state of the atmosphere in the wall before giving the hewer leave to use a naked light and to blast the coal with powder.

A shifter was also burnt by an explosion of fire-damp at Thornley Colliery during the course of the year, to wit, on the 24th May.

At Wingate Grange Colliery a putter was scorched by an explosion of fire-damp, in April, through his having gone past a danger signal with a naked light, contrary to the rules of the colliery.

Another case of scorching by the explosion of a small quantity of fire-damp occurred at Trimdon Colliery, on the 10th of November, scorching a pony putter who improperly went into a place which was not at work with an open light, by which the fire-damp was ignited.

Complaints from Workmen.

During the past year I may mention that I have had two complaints from workmen, one from Brasside Colliery, belonging to the Earl of Durham, as to defective ventilation, and on making an inspection of the mine I found the complaint was not made without reason; the viewer agreed to suspend the working of the pit until a proper furnace, then in the course of erection, was completed.

The other complaint was from a workman at Shincliffe Colliery belonging to Messrs. Love and Spark, and also related to ventilation; in this case, too, I found some cause for the complaint, and obtained a satisfactory promise that immediate steps should be taken to remedy the evil.

Underground Employment and Education of Boys.

The instances of boys being employed in the mines of the district under the age at which educational attainments are required by the Mines Inspection Act are so very rare that I seldom come into contact with them, unless in rare instances of mere suspicion that the parents of a boy may have overstated his age for the purpose of getting him so employed. There are I believe a very few exceptional cases where certificates as to the boy being able to read and write are obtained from a schoolmaster when the boy is professedly under twelve years of age, but even in these cases I believe that they are also required, for the most part, to attend school for the hours that are only required by the Act in the event of their not being certified as being able to read and write.

The very few instances in which boys under 12 years of age are employed underground are, I have reason to suppose, mostly in cases where the mother is a widow, or the family large or in bad circumstances.

There are 171 collieries in this District.

I have, &c.
JOHN J. ATKINSON,
Inspector of Mines.

The Right Hon. H. A. Bruce, M. P.,
H.M. Principal Secretary of State
for the Home Department.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS of LIFE arising therefrom, in the SOUTH DURHAM MINES INSPECTION DISTRICT, during the Year ended 31st day of December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868. Jan. 3	1	North Hetton -	Moorsley -	North Hetton Coal Co. -	James Swift -	Wagon rider	22	Crushed by wagons at screens -	–	–	–	–	1	1
„ 3	2	Water Houses -	Crook - -	Jos. Pease & Partners -	Thos. Morton -	Shifter -	62	Fall of stone while setting heavy timber.	–	1	–	–	–	1
„ 8	3	Brooms Drift -	Consett -	Consett Iron Co. -	Fenwick Scott -	Rolleywayman.	50	Crushed by the 1st of a pony set of two full tubs against lying timber: switches wrong.	–	–	–	1	–	1
„ 15	4	Keepier - -	Durham - -	John Thwaites - -	Wm. Scarth -	Putter -	16	Fall of stone; a putter who had exchanged work with the hewer.	–	1	–	–	–	1
„ 17	5	Shincliffe -	Ditto - -	Love & Spark - -	H. Williamson -	Hewer -	17	Fall of stone in a wide board -	–	1	–	–	–	1
„ 17	6	Oakenshaw -	Willington -	Strakers & Love - -	John Lydon -	Ditto -	25	Crushed in shaft while ascending; he had apparently put his head out of cage.	–	–	1	–	–	1
„ 21	7	St. Helen's (engine pit).	Bishop Auckland	Jos. Pease and Partners -	Chas. Houlder -	Ditto -	22	Fall of stone - - - - -	–	1	–	–	–	1
„ 22	8	Haswell -	Fence Houses -	Haswell, &c. Coal Co. -	John Macgreavy -	Driver -	13	Crushed by tub of plates which was upset upon him by horse taking fright.	–	–	–	1	–	1
„ 23	9	Rainton (Nicholson's pit).	Leamside -	Earl Vane - -	James Kennedy -	Pony-putter	18	Head crushed by tub drawn by pony	–	–	–	1	–	1
„ 24	10	Seaham (No. 2 pit).	Seaham Harbour	Ditto - - - -	Robert Gray -	Hewer -	18	Fall of stone - - - - -	–	1	–	–	–	1
„ 27	11	Burnhope -	Lanchester -	Messrs. Sowerby & Fletcher	John Rowell -	Deputy -	34	Ditto - - - - - -	–	1	–	–	–	1
„ 31	12	Sherburn House	Durham -	Earl of Durham - -	Wales Mason -	Hewer -	29	Ditto - - - - - -	–	1	–	–	–	1
Feb. 5	13	South Durham	Bishop Auckland	Owners of South Durham Colliery.	A. Hargreaves -	Hooker-on -	47	Rapped incline set away without putting chain on: crushed by tubs.	–	–	–	1	–	1
„ 6	14	Seaton - -	Seaham Harbour	Earl Vane - - -	Wm. McGrath -	Pony-putter	13	Crushed by falling over round coal heap with a tub, which fell upon him.	–	–	–	–	1	1
„ 12	15	Coxhoe -	Ferry Hill -	J. Morrison & Partners -	John Lee -	Screenman	32	Crushed by trucks near screens -	–	–	–	–	1	1
„ 14	16	Trimdon -	Ditto - -	Thomas Wood - -	Patrick Graham -	Hewer -	34	Crushed between tub and roof, got on while in motion.	–	–	–	1	–	1
„ 15	17	West Thornley	Tow Law -	Weardale Iron & Coal Co.	John Kelly -	Helper-up -	12	Crushed between tub and roof; he had only worked 2 days.	–	–	–	1	–	1

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868. Feb. 15	18	North Hetton (Moorsley).	Fence Houses	North Hetton Coal Co.	Thos. Lisle	Coal filler	23	Crushed by a wagon on branches, through falling down in front of it.	—	—	—	—	1	1
„ 17	19	South Pelaw	Chester-le-Street	E. M. Perkins & Partners	Henry Bulmer	Hewer	22	Fall of stone; the overman and deputy had shortly before examined the stone.	—	1	—	—	—	1
„ 21	20	North Bitchburn	Darlington	North Bitchburn Coal Co.	Jos. Nicholson	Ditto	48	Fall of stone	—	1	—	—	—	1
„ 25	21	Haswell	Fence Houses	Haswell, &c. Coal Co.	Willm. Dandy	Pony driver	13	Crushed by tubs	—	—	—	1	—	1
„ 26	22	Wingate Grange	Ferry Hill	Executors of late J. Gully	Willm. Dowling	Screenman	—	Crushed between two wagons	—	—	—	—	1	1
Mar. 13	23	Castle Eden	Ditto	Wm. Cook	Matthew Lee	Hewer	18	Fall of stone	—	1	—	—	—	1
„ 14	24	West Auckland	Darlington	Bolckow, Vaughan, & Co.	Francis Clark	Ditto	24	Fell down ladder pit shaft	—	—	1	—	—	1
„ 19	25	Thornley	Ferry Hill	Thornley, &c. Coal Co.	Willm. Daley	Ditto	22	Crushed by fall of stone in a broken jud.	—	1	—	—	—	1
„ 26	26	Wingate Grange	Ditto	Executors of late J. Gully	John Cook	Shifter	—	Was taking a tub along engine bank and was caught by engine train.	—	—	—	1	—	1
„ 30	27	Middle Pit (Murton).	Fence Houses	South Hetton Coal Co.	James McDougle	Pony-putter	13	Crushed by pony tub	—	—	—	1	—	1
April 3	28	Norwood	Bishop Auckland	The Owners of Norwood Colliery.	Ralph Hall	Sheavegreaser	13	Crushed by tub	—	—	—	1	—	1
„ 4	29	South Pelaw	Fence Houses	Hunt, Perkins, & Co.	Mark Leathard	Brakesman	45	Death caused by boiler explosion	—	—	—	—	1	1
„ 6	30	North Hetton	Ditto	North Hetton Coal Co.	Wm. Mitchell	Pony-putter	14	Crushed between tubs and roof	—	—	—	1	—	1
„ 8	31	Pittington	Ditto	Ditto	Rodham Hall	Ditto	14	Crushed between prop and tubs	—	—	—	1	—	1
„ 8	32	Wooley	Darlington	Jos. Pease & Partners	Adam Haslam	Hand-putter	18	Fall of stone	—	1	—	—	—	1
„ 9	33	Coxhoe	Coxhoe	West Hetton Coal Co.	John Smith	Hewer	25	Crushed by fireclay falling on him	—	1	—	—	—	1
„ 9	34	Inkerman	Durham	Messrs. Ferens & Love	John Bell	Horse driver	39	Crushed between wagons at bank	—	—	—	—	1	1
„ 11	35	Low Bitchburn	Crook	John Sharp	John Rennison	Hewer	22	He undermined a prop, and so caused a fall of stone, which caused his death.	—	1	—	—	—	1
„ 23	36	Ryhope	Sunderland	Ryhope Coal Co.	Thos. Harker	Ditto	40	Fall of stone in broken jud	—	1	—	—	—	1
„ 28	37	Haswell	Fence Houses	Haswell, &c. Coal Co.	George Jackson	Deputy	35	Crushed by stone while drawing timber.	—	1	—	—	—	1
„ 29	38	Hunwick	Durham	J. Lancaster & Co.	Martin Nolan	Screenman	55	Crushed between wagons	—	—	—	—	1	1
„ 30	39	Middle Bitchburn.	Crook	Thos. Liddel, Agent	Richard Harrison	Horse keeper	65	Crushed by tubs in the engine plane	—	—	—	1	—	1
May 14	40	Brancepeth	Durham	Messrs. Strakers & Love	Joseph Bowden	Deputy	28	Fall of stone	—	1	—	—	—	1

List of Fatal Colliery Accidents—continued.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.														
May 14	41	Wingate Grange	Ferry Hill -	Executors of late J. Gully	John Emmerson -	Hewer -	29	Fell out of an iron tub to a distance of 20 fathoms.	–	–	1	–	–	1
,, 18	42	Old Etherley -	Auckland -	Henry Sobart & Co. -	John Crossfield -	Rolley driver	14	A set of tubs struck him on the chest.	–	–	–	1	–	1
,, 21	43	Thrislington -	Coxhoe -	James Morrison & Co. -	Wm. Shaw -	Hewer -	38	Fell into the sump and was drowned	–	–	1	–	–	1
June 8	44	Houghall -	Durham - -	Messrs. Love and Spark -	John Higgins -	Pony putter	16	Fall of stone, in broken - -	–	1	–	–	–	1
,, ,,	45	Kelloe - -	Coxhoe -	East Hetton Coal Co. -	John Smith -	Fireman -	—	Boiler explosion - - -	–	–	–	–	1	2
,, ,,	,,	Ditto -	Ditto - -	Ditto - -	Thos. Scarr -	Ditto -	—	Ditto - - -	–	–	–	–	1	
,, 9	46	Framwellgate -	Durham -	Earl Vane - - -	Septimus Turnbull	Engineman	20	Crushed by machinery - -	–	–	–	–	1	2
,, ,,	,,	Ditto -	Ditto - -	Ditto - -	Jonathan Briggs -	Sheavegreaser	12	Ditto - - - -	–	–	–	–	1	
July 1	47	South Kelloe -	Coxhoe -	West Hetton Coal Co. -	Chas. Barrowclough	Hewer -	67	Fall of coal - - -	–	1	–	–	–	1
,, 2	48	Penshaw -	Penshaw -	George Elliot - -	Owen Kirk -	Onsetter -	—	Killed in a drop staple by cage -	–	–	1	–	–	1
,, 7	49	Newfield -	Willington -	Hunwick Coal Co. -	Thos. Tones -	Fireman -	17	Crushed by cage when calling down shaft.	–	–	1	–	–	1
,, 9	50	West Pelton -	Chester-le-Street	Jas. Joicey & Co. -	John Hunter -	Wailer -	13	Injured on head by a stone thrown off screens.	–	–	–	–	1	1
Aug. 1	51	Butterknowle -	Staindrop -	Trustees of late L. Pratman	Wm. Shaw -	Hewer -	24	Fall of stone - - -	–	1	–	–	–	1
,, 7	52	Thrislington -	Ferry Hill -	West Hetton Coal Co. -	Joseph Palmer -	Onsetter -	23	Explosion at the shaft - -	1	–	–	–	–	1
,, 8	53	Brancepeth -	Willington -	Messrs. Strakers and Love	Abraham Hodgson	Hewer -	26	Fall of stone in pillar working -	–	1	–	–	–	2
,, ,,	,,	Ditto -	Ditto - -	Ditto - - -	Michael Clark -	Ditto -	36	Fall of stone in broken - -	–	1	–	–	–	
,, 12	54	Bowburn -	Coxhoe -	West Hetton Coal Co. -	Wm. Waggot -	Onsetter -	—	Crushed by tubs near shaft -	–	–	–	1	–	1
,, 21	55	Castle Eden -	Castle Eden -	Willm. Cook - - -	Edward Horton -	Hewer -	21	Fall of stone - - - -	–	1	–	–	–	1
,, 27	56	Black Boy -	Bishop Auckland	Black Boy Coal Co. -	Thos. Robinson -	Horsekeeper	44	Run over by empty set on engine plane.	–	–	–	1	–	1
,, 31	57	Adelaide -	Ditto - -	Josh. Pease & Partners -	Thos. Allen -	Driver -	14	Crushed by tubs - -	–	–	–	1	–	1
Sept. 5	58	Murton -	Fence Houses -	South Hetton Coal Co. -	Thos. Best -	Hewer -	36	Fall of stone - - - -	–	1	–	–	–	1
,, 8	59	Rainton -	Leamside - -	Earl Vane - -	Robert McChessney	Trapper -	10½	Crushed by a coal tub - -	–	–	–	1	–	1
,, 9	60	Eppleton -	Fence Houses -	Hetton Coal Co. - -	Walter Borthwick	Hewer -	19	Fall of stone - - - -	–	1	–	–	–	1
,, 11	61	Thornley -	Ferry Hill -	Hartlepool Collieries Co. -	Allen Glen -	Ditto -	32	Ditto - - - -	–	1	–	–	–	1
,, 16	62	Pelton - -	Chester-le-Street	W. J. Hutchinson & Partners.	Matthew Herring -	Putter -	44	Ditto - - -	–	1	–	–	–	1
,, 17	63	Wingate Grange	Ferry Hill -	Executors of late J. Gully	James Maddison -	Shaftman -	32	Fell from Low Main seam into sump	–	–	1	–	–	1
,, 21	64	Pelton -	Chester-le-Street	W. J. Hutchinson & Partners.	George Punshon -	Driver -	15	His feet slipped at bottom of shaft, and he fell into the cage hole and was crushed by the cage.	–	–	1	–	–	1

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.														
Sept. 24	65	Bowden Close	Willington	Joseph Pease & Partners	Michael Straker	Hewer	35	Fall of stone	–	1	–	–	–	1
„ 28	66	Eppleton	Fence Houses	Hetton Coal Co.	Wm. Soulsby	Stoneman	46	Ditto	–	1	–	–	–	1
Oct. 2	67	Willington	Willington	Messrs. Strakers & Love	James Southern	Landing-boy	13	He received a blow on the head from the handle of a winch while changing ropes.	–	–	–	1	–	1
„ 7	68	Old Durham	Durham	Earl Vane	John Defty	Pony driver	13	Crushed by empty tubs on engine plane.	–	–	–	1	–	1
„ 23	69	Seaham	Sunderland	Ditto	John Pearce	Hewer	20	Fall of stone	–	1	–	–	–	1
„ 26	70	Greenhead	Durham	Snowdon, Kellett, & Co.	Thos. Hunter	Putter	15	Crushed by tub	–	–	–	1	–	1
„ 27	71	Thornley	Hartlepool	Hartlepool Collieries Co.	Peter Downison	Driver	15	By machinery	–	–	–	1	–	1
Nov. 2	72	Keepier	Durham	John Thwaites	Wm. Dixon Parkin	Hewer	53	Fall of stone	–	1	–	–	–	1
„ 6	73	Eppleton	Fence Houses	Hetton Coal Co.	Joseph Spooner	Deputy	41	Ditto	–	1	–	–	–	1
„ 10	74	Lady Durham	Durham	Earl of Durham	Willm. Lynn	Ditto	60	Fell down shaft from hole at branches.	–	–	1	–	–	1
„ 20	75	Framwellgate	Ditto	Earl Vane	Thos. Knox	Hewer	60	Crushed by tubs	–	–	–	1	–	1
„ 21	76	Woodhouse Close	Bishop Auckland	Sir C. F. McLean, Bart.	Mark Hall	Brakesman	56	Got entangled in underground engine	–	–	–	1	–	1
„ 27	77	Haswell	Fence Houses	Haswell, &c. Coal Co.	Lancelot Johnson	Hewer	34	Fall of stone	–	1	–	–	–	1
„ 29	78	Ryhope	Sunderland	Ryhope Coal Co.	Robt. Donkin	Wagonway-man.	21	Crushed by tubs	–	–	–	1	–	1
Dec. 3	79	Castle Eden	Ferry Hill	Wm. Cook	Wm. Dower	Sinker	28	A piece of plank fell down the shaft upon him.	–	–	1	–	–	1
„ 10	80	Elm Park	Crook	Bainbridge & Kirsopp	John Willis	Hewer	17	Fall of stone	–	1	–	–	–	1
„ 12	81	Iveston	Medomsley	Consett Coal Co.	Wm. Lupton	Ditto	36	Fall of coal	–	1	–	–	–	1
„ 16	82	Seaham	Sunderland	Earl Vane	Willm. Ford	Heap keeper	62	Killed at apparatus	–	–	–	–	1	1
„ 19	83	Haswell	Fence Houses	Haswell, &c. Coal Co.	Wm. Wild	Deputy	50	Fall of stone	–	1	–	–	–	1
„ 21	84	Page Bank	Willington	Bell Brothers	John Greenwell	Screener	11	Crushed between wagons at bank	–	–	–	–	1	1
								Total	1	36	10	25	15	87

Mr. Dickinson's Report.

REPORT on the INSPECTION of MINES in the NORTH and EAST LANCASHIRE or MANCHESTER DISTRICT for the Year ended 31st December 1868.—BY JOSEPH DICKINSON, Esq., F.G.S.

SIR, Pendleton, Manchester, 27th February 1869.

Working of the regulations.

IN accordance with the Act 23 & 24 Vict., c. 151, I have the honour to report to you that the Acts for the regulation and inspection of coal mines appear to be working satisfactorily in this district; and that the number of fatal accidents and deaths, and the proportion of them to the number of persons employed, and to the quantity of coal wrought, is low, as compared with prevous years.

The accidents.

The number of separate fatal accidents in the year 1868 amounts to 61, and the deaths therefrom to 65. The average for the ten years ending 1861, when much fewer persons were employed, was 63·3 fatal accidents, and the deaths 90 per annum; so that, independently of the increase in the number of persons employed and the quantity of coal wrought, there is simultaneously a decrease of fatalities.

Year.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	10 Years Average.	1862.	1863.	1864.	1865.	1866.	1867.	1868.
Separate Accidents.	60	60	73	78	73	52	60	55	55	67	63·3	56	60	60	61	55		
												Transferred portion				3		
																58	71	61
Deaths	113	82	87	89	84	99	138	68	58	82	90·0	59	68	64	66	66		
												Transferred portion				3		
																69	84	65

Proportion of accidents to persons employed and coal wrought.

As to the proportion of accidents and deaths to the number of persons employed and to the quantity of coal wrought, I have, as in previous years, made application to each owner, and in reply the number of persons employed and the quantity of coal wrought has been furnished to me from all except three collieries; I am, therefore, enabled to state the proportions with the nearest possible approach to accuracy. The three collieries from which I have not received returns on this occasion are the Bentgrange, Dootson-vauze, and Seedfield, the numbers for which I have computed at 89 persons and 26,932 tons. With this small exception the results arrived at are from actual returns. They show that in the year 1868 the total number of persons employed in and about the collieries averaged 26,360, and that 7,053,000 tons of coal were wrought. By dividing the number of fatalities into these numbers it will be found that there has been 1 separate fatal accident to every 432 persons employed, and to every 115,623 tons of coal wrought; and 1 death to every 405 persons employed, and to every 108,508 tons of coal wrought. These proportions are, in round numbers, about twice as favourable as they were at the commencement of the inspection of coal mines, nearly 20 years ago.

Kind of accidents.

The fatal accidents in 1868 consisted of—

4	by	explosions of fire-damp - -	causing	5	deaths
33	„	roof and coal falling - - -	„	33	„
6	„	shaft accidents - - - -	„	8	„
15	„	miscellaneous accidents below ground -	„	16	„
3	„	ditto ditto on the surface -	„	3	„
61				65	

The circumstances under which each of the fatal accidents happened are described in the accompanying detailed lists.

Non-fatal accidents.

The reports of personal but not fatal injuries by explosions show that, in addition to the fatal accidents, personal injuries were received in 27 instances by firedamp, in 10 by blasting powder, and in 1 instance by the explosion of a steam boiler. The other non-fatal accidents having only to be reported when the injury is considered serious, allows so much latitude in determining what is *serious* that the numbers are not sufficiently reliable to be worth recording. It may be specified, however, that as many as 27 instances have been reported of injuries by waggons below ground.

Drawbacks.

In the list of fatal accidents there is one to a person whilst getting the cage out of the shaft, where it had been fixed by the safety apparatus when the rope broke; and in the reports of non-fatal accidents there is also an instance of a person at the bottom of a shaft being struck by a falling stone that glanced off the pointed cover to the cage. The safety apparatus affords security in so many instances that a drawback of this kind is but little against it; but it is not so clear whether a pointed instead of a flat cover does not introduce as much danger as it averts.

Precautions.

In each instance of neglect or accident, which has appeared to require it, I have endeavoured to get the regulations complied with in future. And as the best means of making well known the precautions which appear to be generally requisite at present, I have sent to each colliery a circular letter, pointing out, that,—

1st. The miners require to be frequently cautioned to set sprags and props, as large blocks of stone and coal, which sound solid, fall without warning.

2nd. Trams or waggons should be more carefully secured from getting loose on slopes or inclines. And, before waggoners are allowed to take waggons down a slope, it should be ascertained that they can stop the waggon if required, so as to avoid overtaking and running over their fellow waggoners who are in advance, and to give persons on the road time to get out of the way, and, where there is only one line of rails, to avoid coming into dangerous collision with any one pushing a waggon up the slope.

3rd. In blasting, an iron, instead of a wooden or a copper rammer, is still too often used in getting the wadding and first part of the stemming fairly bedded on to the powder; and shots which have missed fire are still drawn, although experience shows that even with water in the hole the drill goes in advance and fires the powder. The best way being to put a small shot near enough to fire both charges. The practice of taking barrels and large quantities of powder down the pit should be discontinued.

4th. As to ventilation, a recent decision of the judges shows that parts of the mine which are not being worked but to which a person could find access, or from whence gas might issue, so as dangerously to affect any working place or travelling road, have to be kept ventilated as well as the working places and travelling roads. The appointed station for work persons to stop at should therefore be carefully defined and adhered to.

And I give notice, that I require covers to be provided and used overhead when lowering or raising persons in all working pits or shafts except in those worked by a gin or a windlass, or whilst sinking or pump work is being done, or, in special cases, where written exemption is obtained from me annually.

Penalties.

The neglect which has come under my notice at two of the collieries during the year has appeared beyond what I should adjudicate upon, and I, therefore, caused proceedings to be taken for the penalties. In one of these, the owner of the Rose-hill colliery was fined 10*l.* for not providing adequate ventilation against firedamp, and 5*l.* for not providing a place of refuge on a self-acting inclined plane. In the other, the owner of the Farnworth colliery (which is now closed) was fined 5*l.* for not providing adequate ventilation against blackdamp, the candles where the men were at work going out when placed upright. These sums have been paid to the respective clerks to the justices, to be paid over to the receiver of government fines, as the Act directs. In an adjoining district, during the illness of one of my colleagues, I had also to cause proceedings to be taken against the owner of the Afon-eitha colliery for neglecting to provide a second outlet to the colliery. This penalty, a sum of 10*l.*, was divided between a miner and a boy who were marvellously rescued after being shut up in the pit for eight days, by the sides of the shaft falling in.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS OF LIFE arising therefrom, in the NORTH and EAST LANCASHIRE or MANCHESTER DISTRICT, under Mr. DICKINSON'S Inspection, during the Year 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868. Jan. 13	1	Moston	Manchester	Executors of John Stanley	Joseph Thompson	Assistant hooker-on.	15	Crushed by the cage, which was started unexpectedly. The engineman stated that the signal was given to go on, but the head hooker-on denied it.	–	–	1	–	–
„ 20	2	Bankhouse	Shaw	Oldham, Middleton, and Rochdale Co. (Limited.)	Thomas Owen	Waggoner	10	Caught by a waggon from which the skotch had got out of the wheel. It ran against the waggon which he and another boy were pushing up an ascending road.	–	–	–	1	–
„ 22	3	Dootson Vauze	Blackrod	Samuel Leather	Anthony Milner	Miner	42	Roof falling upon him in the drawing road, as he was passing with a waggon.	–	1	–	–	–
Feb. 4	4	Agecroft	Pendlebury	Andrew Knowles and Sons	John Greenhalgh	Boy	—	Run over by a waggon which he and other boys were taking down a brow.	–	–	–	1	–
„ 25	5	Hudclough	Facit	Smithson and Butterworth	James Bridge	Miner	32	Roofstone, which broke off at a seam, falling upon him.	–	1	–	–	–
„ 28	6	Bank Top	Radcliffe	Knowles and Hall	John Birch	Ditto	45	Roofstone falling at a slip. It fell over a prop.	–	1	–	–	–
Mar. 6	7	Bank	Little Hulton	John Wright	Giles Eckersley	Waggoner	16	Roof falling at a slip, in the face of a bay in the Cannel mine.	–	1	–	–	–
„ 17	8	Clifton Hall	Clifton	Andrew Knowles and Sons	James Potter	Miner	—	Roof coal in the Trencherbone mine falling after a chock was taken out. He died in the Salford Dispensary.	–	1	–	–	–
„ 19	9	Glodwick	Oldham	James Collinge and Co.	Thomas Mills	Ditto	30	Burned by firedamp which he fired on going into an old working. He had been in the same place a few hours before and found no gas, but he ought not to have returned without taking a safety lamp to ascertain that the ventilation was being maintained. Died 8th April.	1	–	–	–	–

List of Fatal Colliery Accidents.—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868. Mar. 27	10	Heyfield	Westleigh	James Diggle	Richard Nalty	Miner	27	Coal in the 6-feet mine falling upon him.	–	1	–	–	–
" 30	11	Pendlebury	Pendlebury	Andrew Knowles and Sons	Thomas Sweeney	Ditto	36	Struck by a crane handle whilst letting a full waggon down a steep bay in the Crumbouke mine.	–	–	–	1	–
April 6	12	Bower	Hollinwood	Messrs. Marland	John Whitaker	Ditto	32	A stone falling upon him from the roof. He had failed to get it down with wedges and a crowbar; but it fell without warning as he was underneath, stemming a shot to blow it down. It should have been propped before he went underneath.	–	1	–	–	–
" 8	13	How Bridge	Atherton	John Fletcher and others	Charles Rothwell	Ditto	24	Coal which he was taking down in the great 7-feet mine falling upon him. It did not fall as he expected, and he incautiously, without re-setting the sprags, went underneath to undermine it a little more.	–	1	–	–	–
" 9	14	Bradford	Manchester	Bradford Co.	James Stafford	Boy	14	Roof falling at a slip in the waggon road.	–	1	–	–	–
" 16	15	Manor	Kearsley	Clifton and Kearsley Co.	Thomas Basil	Waggoner	13	Coal falling in the Doe mine	–	1	–	–	–
" 21	16	Chadwick Hall	Rochdale	Roscow and Lord	- - -	Miner	—	Roof falling. He died 5th Sept.	–	1	–	–	–
" 22	17	Lower Moor	Oldham	Mayall and Seddon	William Lowe	Ditto	40	Coal falling upon him, and further injuries afterwards by the rope breaking at the socket, as he was being sent up the engine brow. Died 24th.	–	1	–	–	–
" 29	18	Altham	Accrington	W. E. Taylor (Altham Co.)	James Cronshaw	Ditto	39	Roof falling in some old workings near the outcrop in a clough.	–	1	–	–	–
May 1	19	Kearsley	Kearsley	Samuel Scowcroft	William Dearden	Ditto	46	Coal falling off to a back as he was beginning a new place at the side of a level.	–	1	–	–	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868. May 6	20	Dearnley	Smallbridge	Schofield and Co.	Charles Whipp Samuel Cheetham	Waggoner Miner	15 39	Explosion of firedamp. Whipp died on the 14th, and Cheetham on the 16th. The fireman, although he had discovered that adequate ventilation was not being maintained up to the face, allowed them to go in to disperse the gas, when, being inexperienced, they took a candle too near, and lighted the gas. The underlooker and the fireman were censured by the coroner's jury, and the owners requested to see that the rules were adhered to in future.	2	–	–	–	–
„ 8	21	Holebottom	Oldham	Leeses, Jones, and Co.	Hugh Nield	- - -	—	Caught by a waggon which ran violently down a short self-acting brow; he having omitted to hook his empty waggon at the bottom.	–	–	–	1	–
„ 23	22	Pendlebury	Pendlebury	Andrew Knowles and Sons	William Wallwork	Bricklayer's labourer.	—	Killed by getting his arm drawn over a pulley as he was attempting to attach a balance weight without the engine being stopped.	–	–	–	–	1
„ 29	23	Chadwick Hall	Rochdale	Roscow and Lord	Edward Chadwick Edward Hartley	Miner Ditto	18 22	Burned by an explosion of powder. They were charging a hole with an iron scraper, when the powder went off, about 8 pounds besides being fired; but it could not be ascertained whether the scraper struck fire at a piece of rock, or whether one of the deceased put his candle to the hole.	–	–	–	2	–
„ 29	24	Martholm	Great Harwood	Richard Fort, M.P.	John Aldred	Ditto	—	Coal falling from the side of a level as he was doing some repairs. It fell from the break which usually takes place at the side of a level; and he should have set sprags.	–	1	–	–	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868. May 30	25	Manor	Kearsley	Clifton and Kearsley Co.	Benjamin Thomas	Driver	14	Run over by waggons on the colliery railway, his foot having caught the switch as he was unhooking the horse. Died in the infirmary.	—	—	—	—	1
June 11	26	Pendleton	Pendleton	Andrew Knowles and Sons	Jeremiah Buckley	Miner	—	Roof falling in the Rams mine. Died in the infirmary.	—	1	—	—	—
„ 13	27	Westleigh	Westleigh	Wigan Coal and Iron Co. (Limited).	James Smith	Waggoner	16	Caught between two tubs in the balance brow, a tub at the top of the brow having been hooked by mistake to a piece of loose chain instead of to the balance chain.	—	—	—	1	—
„ 17	28	Broadfield	Westleigh	John Speakman	William Isherwood	Miner	45	Coal falling upon him when at his work.	—	1	—	—	—
„ 20	29	Denton Lane	Chadderton	Chamber Co.	Thomas Eckersley	Ditto	20	Stone falling upon him at a fault	—	1	—	—	—
„ 24	30	Mangnalls	Worsley	Bridgewater Trust	William Clare	Waggoner	19	Roof coal falling in the 7-feet mine	—	1	—	—	—
„ „	31	Welch Whittle	Welch Whittle	James Darlington	John Baxendale	Ditto	—	Explosion of firedamp. Died 4th July. He omitted to try his place with a safety lamp on returning, to see if adequate ventilation had been maintained whilst he was out with a waggon.	1	—	—	—	—
„ 26	32	Bardsley	Ashton-under-Lyne	Bardsley Co.	Jos. Appleton	Ditto	18	Shale from the roof breaking the timbering, about ten yards from the face of the work, as he and the collier were underneath with a waggon.	—	1	—	—	—
„ 27	33	Stopes	Little Lever	Thomas Fletcher	John Berry	Miner	31	Coal falling from the roof in the 10-feet mine. Died 23d July.	—	1	—	—	—
July 1	34	No. 11 Yard	Hulton	Hulton Co.	Ralph Halliwell	Ditto	—	Roof falling, when he returned after firing a shot. Died 15th Sept.	—	1	—	—	—
„ 2	35	Cat Hole	Baxenden	Hargreaves, Ashworth, and Co.	Peter Parker	Metal-man	25	A shot going off as it was being rammed. An iron, instead of a wooden or copper rammer being used in getting the first part of the ramming bedded on to the wadding over the powder.	—	—	—	1	—

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868. July 2	36	Raikes - -	Great Lever -	Earl of Bradford - -	Jeremiah Greenhalgh.	Boy -	13	Hurt at a shunt by a train of waggons on the engine plane, the signal to go on having been given too soon by some one. Died 13th Sept.	–	–	–	1	–
„ 27	37	Haughton Green	Haughton - -	Thomas Shaw and Sons -	John Stansfield -	Deputy fireman.	—	Run over by a waggon which a boy 14 years old let go on the jig brow in the Peacock mine. Died in the Manchester infirmary.	–	–	–	1	–
Aug. 4	38	Broadfield -	Westleigh - -	John Speakman - -	Charles Thorpe -	Man -	—	Found dead in the saw-pit, into which it appeared he fell, and got suffocated amongst the sawdust.	–	–	–	–	1
„ 6	39	Great Boys -	Tyldesley - -	Fletcher and Scowcroft -	John Lloyd -	Miner -	35	Killed by a shot blowing the coal upon him as he returned too soon.	–	–	–	1	
„ 7	40	Rose Hill -	Bolton - -	Samuel Scowcroft - -	James Grundy -	Ditto -	23	Suffocated in firedamp. The pit had not been at work for some days, and the men were allowed to return to work before it had been put right. The deceased passed the danger signal.	–	–	–	1	–
„ 8	41	Allens Green -	Radcliffe - -	Knowles and Hall -	Robert Buckley -	Ditto -	17	Crushed between two waggons. He was going in front of one down a slope, and without a sprag in a wheel.	–	–	–	1	–
Sept. 4	42	Woodhouse Lane	Bagslate - -	Zachariah and James Howarth.	Richard Birtwisle	Ditto -	20	Roof falling in a work, about 7 yards from the entrance.	–	1	–	–	–
„ 11	43	Black Lane -	Radcliffe - -	Rylands and Sons -	James Marland -	Master sinker.	50	Thrown out of the hoppet as he was coming up the sinking pit. The winding pulley was not in a straight line with the drum, a guide pulley was therefore used, and it appeared that it broke loose and caused the rope to slip off the drum.	–	–	1	–	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives Lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868. Sept. 30	44	Albert	Westhoughton	John Gerrard	Thomas Hartley	Miner	24	Roof falling, not enough props set	–	1	–	–	–
Oct. 1	45	Singing Clough	Kearsley	Knowles and Stott	Thomas Heathcote	Engineer	17	Burned by an explosion of firedamp in the Cannel mine. He drew the staple, by which the entrance was barred and locked, and went into the return airway with an open light as some gas was being driven off by a new cutting into the goaf. Died 6th.	1	–	–	–	–
„ 8	46	Albert	Hollinwood	Chamber Co.	William Henry Ogden.	Pony driver	18	Crushed by a waggon. The front end, on which he was riding, broke.	–	–	–	1	–
„ 22	47	Kearsley	Kearsley	Samuel Scowcroft	James Seddon	Banksman	—	Falling down the shaft to the Trencherbone mine. Self-acting fences were provided, but one of them was off at the time for the purpose of taking out a water tank and putting in the cage.	–	–	1	–	–
„ „	48	Tyldesley	Tyldesley	Astley and Tyldesley Co. (Limited).	Roger Cook	Waggoner	20	Coal, &c., falling in the 6-feet mine.	–	1	–	–	–
„ 28	49	Broadfield	Oswaldtwistle	Thomas Simpson and Co.	Peter Hayes	Miner	30	Roof falling as he was taking out part of a pillar of coal.	–	1	–	–	–
Nov. 2	50	Outwood	Outwood	Thomas Fletcher and Sons	Joseph Barlow	Ditto	—	Roof of the 2-yards mine falling upon him.	–	1	–	–	–
„ „	51	Elton	Bury	William Thornton Parks	George Lowe	Ditto	22	Roof falling where he was at work	–	1	–	–	–
„ „	52	Black Lane	Radcliffe	Rylands and Sons	John Delasay, Christopher Green, Moses Atkinson.	Master sinker Sinker Sinker	28 30 24	The brickwork of the shaft which they had put in giving way. They were aware that the bottom had become loosened by two shots, and they had just gone down to make an examination. The rings above ought either to have been plugged underneath, or to have rested on solid ground at the back part.	–	–	3	–	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868. Nov. 9	53	Hapton Valley	Hapton	Executors of John Hargreaves.	James Granger	Waggoner	12	Caught by a waggon in the drawing road. Died 20th.	–	–	–	1	–
" "	54	Ringley Fold	Stoneclough	Knowles and Stott	Thomas Greenhalgh	Pit carpenter	36	Falling from part way down the shaft. In getting the broken rope away from the cage, which was held by safety catches, the catches became lifted by the rope, thereby loosening the cage, and he being on the top of it, fell with it to the bottom of the shaft.	–	–	1	–	–
" 10	55	Cleggswood	Littleborough	Robert Knowles and Co.	Henry Butterworth	Miner	41	Roof falling in the bay where he was working.	–	1	–	–	–
" 24	56	Tong	Bolton	Jethro Scowcroft	Henry Entwistle	Ditto	27	Roof falling in the Little mine, as he was taking the coal down.	–	1	–	–	–
" 27	57	Burnt Hills	Wholaw Nook	Executors of John Hargreaves.	James Ashworth	Ditto	45	Roof falling as he was taking out a prop.	–	1	–	–	–
Dec. 12	58	Outwood	Outwood	Thomas Fletcher and Sons	Giles Grundy	Assistant hooker-on.	12	Crushed by the cage at the 4-feet working. He, apparently, was lifting the catch before the cage had stopped.	–	–	1	–	–
" 15	59	Lords Fields	Ashton-under-Lyne	Lords Fields Co.	James Rushworth	Miner	25	Roof falling in a stowage place in the Great mine.	–	1	–	–	–
" 17	60	Woodpark	Bardsley	Leeses and Booth	James Chadwick	Ditto	26	Collision of waggons. He was pushing an empty tub up a slope when two waggoners with a full tub came down at full speed, there being two screens across the road for turning the air which prevented the waggoners seeing or hearing beyond.	–	–	–	1	–
" "	61	Clayton	Manchester	Leigh and Bradbury	James Lovatt	Ditto	30	Roof falling as he was taking a piece of coal out of the side.	–	1	–	–	–
								Total, 61 fatal accidents and 65 deaths	5	33	8	16	3

LIST of the OWNERS and COLLIERIES in the MANCHESTER DISTRICT of LANCASHIRE, specifying those where FATAL ACCIDENTS have taken place, in the Year 1868.

Number.	Owners.	Address.	Collieries.	Where situated.	Fatal Accidents.	Lives lost.
1	Altham Co.	Atham, Accrington	Altham	Altham	1	1
2	Arley Main Co.	Blackrod, Chorley	Park Hall	Blackrod		
3	Edward Ashworth and Co.	Cowpe, Waterfoot, Manchester.	Brandwood Moor	Brandwood Moor.		
4	Ralph Ashworth and Co.	Littleborough	Starring	Littleborough.		
5	Astley and Tyldesley Coal and Salt Co. (Limited).	Tyldesley, Manchester	Astley,	Astley,		
6			Tyldesley.	Tyldesley	1	1
7	Joseph Bagnall	Royton, Oldham	Higginshaw	Royton.		
8	Bailey and Dronsfield	Oldham	Park	Oldham.		
9	Bankhouse Co.	Bagslate, Rochdale	Bankhouse	Bagslate.		
10	Bardsley Co.	Ashton-under-Lyne	Bardsley	Bardsley	1	1
11	James Barker	Charnock Richard, Chorley.	Pemberton House	Charnock Richard.		
12	James Barlow	Entwistle, Bolton	Cranberry Moss	Over Darwen.		
13	Exors. of Joseph Barnes	Church, Accrington	Dunkenhalgh Park	Church.		
14	Matthew Bennett and Brothers.	Little Hulton, Bolton	Street Gate	Little Hulton.		
15	John G. Blackburne	Oldham	Lowside	Oldham.		
16	Booth and Marland	Ditto	Honeywell Lane	Ditto.		
17	The Earl of Bradford	Great Lever Collieries, Bolton.	Great Lever	Great Lever.		
			Hacken	Darcy Lever.		
			Raikes	Great Lever	1	1
18	Bradford Co.	Bradford, Maachester	Bradford	Manchester	1	1
19	James Brearley and Son	Brandwood Moor, Waterfoot.	Brandwood Moor	Brandwood Moor.		
20	Bridgewater Trustees	Worsley, Manchester.	Ashtonsfield	Little Hulton.		
21			Barracks	Ditto.		
22			Bridgewater	Worsley.		
23			Buckley Lane	Little Hulton.		
24			Burgess Land	Ditto.		
25			Delph	Middle Hulton.		
26			Edge Fold	Worsley.		
27			Ellenbrook	Tyldesley.		
28			Gatley	Ditto.		
29			Howarths Field	Farnworth.		
30			Linnyshaw	Worsley.		
31			Lords Moss Field	Farnworth.		
32			Madams Wood	Little Hulton.		
33			Mangnalls	Worsley	1	1
34			Mosley Common	Tyldesley.		
35			Sanderson	Worsley.		
36			Saplingfield	Middle Hulton.		
37			Tonges Field	Farnworth.		
38			Wardley Coppice Field.	Worsley.		
39	Brimrod Co.	Rochdale	Brimrod	Rochdale.		
40	Brooks and Pickup	Towneley, Burnley	Cupola	Hameldon.		
41			Towneley	Burnley.		
42			Wholaw Nook	Wholaw.		
43	John Buckley	Healey, Rochdale	Birches and Whitewell.	Healey.		
44	Adam Bullough	Waterside, Darwen	Waterside	Eccleshill.		
45	Bury Colliery Co.	Bury	Bury	Bury.		
46	Butterworth and Brooks	Sunnyside, Rawtenstall.	Cragg	Bacup.		
47	Edmund Butterworth and Sons.	Crompton, Oldham	Crow Knowl	Crompton.		
48	The Exors. of James Butterworth.	Bacup	Oaken Clough	Bacup.		
49	James Butterworth and Son	Rochdale	Greenbooth and Knowl.	Wolstenholme.		
50	Thomas Butterworth	Oldham	Bent Grange	Oldham.		
51	Chamber Company	Hollinwood	Oak	Hollinwood	1	1
52			Chamber	Oldham.		
53			Chadderton	Chadderton	1	1
54	Francis Charlton	Little Hulton, Bolton	Wharton	Little Hulton.		
55	Edmund Clegg and Son	Littleborough	Turf House	Littleborough.		

List of the Owners and Collieries in the Manchester District, &c.—*continued.*

Number.	Owners.	Address.	Collieries.	Where situated.	Fatal Accidents.	Lives lost.
56	Clifton and Kearsley Co.	Clifton, Manchester	Botany Bay	Clifton.		
57			Bus	Ditto.		
58			Robin Hood	Ditto.		
59			Manor	Kearsley	2	2
60			Spindlepoint	Ditto.		
61			Wetearth	Clifton.		
62	Cliviger Co.	Cliviger, Burnley	Coppy	Cliviger.		
63			Union	Ditto.		
64	James Collinge and Co.	Oldham	Glodwick	Oldham	1	1
65	Thomas Cross	Halliwell, Bolton	Doffcocker	Halliwell.		
66	Charles Crossley	Wardle, Rochdale	Crook Bank	Wardle.		
67	Darcy Lever Co.	Darcy Lever, Bolton	Darcy Lever	Darcy Lever.		
68	James Darlington	Blainscough Hall Colliery, Coppull, Chorley.	Blainscough Hall	Coppull.		
69			Springfield	Ditto.		
70			Welch Whittle	Welch Whittle	1	1
71	James Dearden	The Orchard, Rochdale.	Cartridge Nook	Wardle.		
72			Handle Hall	Calderbrook.		
73			Italy	Dulesgate.		
74			Land	Shawforth.		
75			South Grain	Dulesgate.		
76			Toadleach	Healey.		
77			Todmorden Moor	Dulesgate.		
78			Tooter Hill	Bacup.		
79			Wallnook	Wardle.		
80	Dewhursts, Hoyles, and Smethurst.	Anderton Hall Colliery, Blackrod, Chorley.	Anderton Hall	Blackrod		
81			Rigby Hill	Ditto.		
82	James Diggle	Westleigh and Heyfield Collieries, Leigh, Manchester.	Heyfield	Westleigh	1	1
83			Owens	Ditto.		
84			Westleigh	Ditto.		
85	Exors. of Lawrence Duckworth.	Sheep Hey, Ramsbottom.	Scout Moor,	Shuttleworth.		
86			Shipperbottom	Walmersley.		
87	T. and J. Eccles	Coney Colliery, Over Darwen.	Coney	Over Darwen.		
88	Eccleshill Co.	Over Darwen	Flash	Eccleshill.		
89	Ralph Entwhistle	Over Darwen	Over Darwen Brickworks.	Over Darwen.		
90	Edmund Fairburn	Wardle, Rochdale	Bank Hey	Wardle.		
91	Fish and Holden	Over Darwen	Old Lyons	Over Darwen.		
92	Nicholas Fish	Rivington, Bolton	Wilderswood	Rivington.		
93	H. H. Fishwick and Co.	Rochdale	Brotherod	Rochdale.		
94	James Fletcher and Brothers	Littleborough	Higher Shore	Littleborough.		
95	John Fletcher	Little Lever, Bolton	Ladyshore	Little Lever.		
96	John Fletcher and others	Atherton Colliery, near Manchester	Chanters	Atherton.		
97			Gibfield	Ditto.		
98			Howbridge	Ditto	1	1
99	Thos. Fletcher	Bradley Fold Collieries, Little Lever, Bolton	Stopes	Little Lever	1	1
100			Bents	Ditto.		
101			Black Moss	Radcliffe.		
102			Breightmet	Breightmet.		
103			Radcliffe Moor	Ainsworth.		
104	Thos. Fletcher and Sons	Near Manchester	Outwood	Outwood	2	2
105	Fletcher and Scowcroft	Great Boys Colliery, Tyldesly	Great Boys	Tyldesley	1	1
106			Pear Tree House	Ditto.		
107	Exors. of Thos. Fogg	Edgeworth, Bolton	Horrocks Court	Edgeworth.		
108	Exors. of Richd. Fort	Great Harwood Colliery, near Accrington	Great Harwood	Great Harwood.		
109			Martholm	Ditto	1	1
110	John Gerrard	Westhoughton, Bolton	Albert	Westhoughton	1	1
111	John Gibson and Co.	Little Hulton, Bolton	Smithfold	Little Hulton.		
112	John Gregory	Leigh, Manchester	Snapes	Westleigh.		
113	Reuben Haigh and Co.	Walsden, Todmorden	Foulclough	Todmorden.		
114	Hall and Rogers	Littleborough	Cleggswood Pottery	Littleborough.		
115	Hall and Urmson	Bagslate, Rochdale	Moss	Bagslate.		
116	James Hardcastle	Firwood, Bolton	Bradshaw and Harwood.	Harwood.		
117	Ditto	Bolton	Breightmet	Breightmet.		
118	James Hardman	Stacksteads	Wellclough	Stacksteads.		

List of the Owners and Collieries in the Manchester District, &c.—*continued.*

Number.	Owners.	Address.	Collieries.	Where situated.	Fatal Accidents.	Lives lost.
119	Exors. of John Hargreaves	Burnley, &c. Collieries, Burnley	Bank Hall	Burnley.		
120			Burnt Hills	Wholaw Nook	1	1
121			Cornfield	Gawthorpe.		
122			Foxclough	Colne.		
123			Gannow	Habergham.		
124			Hapton Valley	Hapton	1	1
125			Marsden	Marsden.		
126			Padiham	Padiham.		
127			Rowley	Burnley.		
128			Whittlefield	Ditto.		
129	Hargreaves, Ashworth and Co.	Baxenden Colliery, Accrington	Cat Hole	Broad Oak	1	1
130			Hole in Band	Accrington.		
131			Victoria	Baxenden.		
132			Wood Nook	Accrington.		
133	Ditto	Rossendale Collieries, Newchurch	Brex	Lower Whitwell Bottom.		
134			Dean	Water.		
135			Foxhill	Middle Whitwell Bottom.		
136			Grime Bridge	Ditto.		
137			Scar End	Ditto.		
138			Meadows	Bacup.		
139			Old Clough	Ditto.		
140			Swinshaw	Crawshaw Booth		
141			Stacksteads	Stacksteads.		
142	Haugh Hey Co.	Rochdale	Haugh Hey	Haugh Hey.		
143	John Haworth	Bury	Cheesden Bar	Bury.		
144	Heaton and Co.	Heath Charnock Pottery, Chorley.	Heath Charnock	Heath Charnock		
145	Heskin Hall Co.	Heskin, Chorley	Heskin	Heskin.		
146	John and Ralph Holden	Over Darwen	Back-o'-th'-height	Blacksnape.		
147	Zech. and James Howarth	Rochdale	Woodhouse Lane	Woodhouse Lane	1	1
148	Wm. Ford Hulton	Bolton	Hulton and	Hulton	1	1
149			Hulton Park	Ditto.		
150	Hurst Co. (Limited)	Ashton-under-Lyne	Hurst	Hurst.		
151	Kay and Wilks	Oldham	Little End	Oldham.		
152	Kershaw Brothers	Littleborough	Longley Hey	Longley Hey.		
153	William Knight	Horwich, Bolton	Newfields	Horwich.		
154	Andrew Knowles & Sons	Pendlebury, Manchester.	Agecroft	Pendlebury	1	1
155			Clifton Hall	Clifton	1	1
156			Clifton Moss	Clifton.		
157			Pendlebury	Pendlebury	2	2
158			Pendleton	Pendleton	1	1
159	Ditto	Little Lever, Bolton	Farnworth Bridge	Little Lever.		
160			Fearneyside	Ditto.		
161			Foggs	Darcy Lever.		
162			Rivin, New	Little Lever.		
163	Ditto	Sharples, Bolton	Sharples	Sharples.		
164	Robert Knowles and Co.	Littleborough	Cleggswood	Littleborough	1	1
165	Knowles and Hall	Radcliffe Colliery, near Manchester.	Radcliffe	Radcliffe	1	1
166			Bank Top	Ditto	1	1
167	Knowles and Stott	Stoneclough, Kearsley, Manchester.	Little Hey	Stoneclough.		
168			Ringleyfold	Ringley	1	1
169			Singingclough	Kearsley	1	1
170	A. and W. Law	Littleborough	Lydgate	Lydgate.		
171	Executors of James I. Law	Bacup	Greave New	Bacup.		
172	Thomas Leach	Stacksteads	Lee	Ditto.		
173	Samuel Leather	Blackrod, Chorley	Dootson Vauze	Blackrod	1	1
174	Robert Lees	Britannia, Bacup	Freeholds	Facit.		
175			New Line	Bacup.		
176	Lees and Ashworth	Hollingworth, Littleborough.	Syke	Hollingworth.		
177	Leeses and Booth	Fairbottom Colliery, Ashton-under-Lyne.	Broad Oak and Moss	Broad Oak.		
178			Dock	Fairbottom.		
179			Hartshead	Hartshead.		
180			Heys.	Ashton-under-Lyne.		
181			Nelson and Rocher	Park.		
182			Woodpark	Bardsley	1	1
183	Lees and Co.	Oldham	Greenacres	Oldham.		
184	Leeses, Jones, and Co.	Ditto	Holebottom	Ditto	1	1
185			Rhodes Bank	Ditto.		

List of the Owners and Collieries in the Manchester District, &c.—*continued.*

Number.	Owners.	Address.	Collieries.	Where situated.	Fatal Accidents.	Lives lost.
186	Lees and Mayall	Greenacres Moor, Oldham.	Little Mine	Higher Barrowshaw.		
187	Lees and Tetlow	Littleborough	Light Owlers and Pike House.	Littleborough.		
188	Leigh and Bradbury	Denton, Manchester	Broomstair	Denton.		
189	Ditto	Clayton, Manchester	Clayton	Clayton	1	1
190	Limehurst Company	Ashton-under-Lyne	Limehurst	Ashton-under-Lyne.		
191	Lomax and Co.	Rochdale	Smallbridge	Smallbridge.		
192	John Lomax and Co.	Rochdale	Old Sink and Greenlands.	Rowley Moor.		
193	John and Nathl. Longworth	Westhoughton, Bolton	Brinsop	Westhoughton.		
194	John Lord	Bacup	Deansgreave	Bacup.		
195	Samuel Lord and Brothers	Wolstenholme, Rochdale.	Bamford Closes	Wolstenholme.		
196	Lords Fields Co.	Ashton-under-Lyne	Lords Fields	Ashton-under-Lyne.	1	1
197	Mrs. Ann Maden	Bacup	Hogshead	Bacup.		
198	Messrs. Marland	Hollinwood, Manchester.	Bower	Hollinwood	1	1
199	George Maxwell	Bacup.	Greave Clough	Bacup.		
200	Adam Mason	Horwich, Bolton	Winter Hill	Horwich.		
201	Mayall and Seddon	Oldham	Lower Moor	Oldham	1	1
202	Meadow Head Co.	Rochdale	Meadow Head	Wolstenholme.		
203	George Mellodew	Oldham	Hodgeclough	Oldham.		
204	E. D. Milnes and Brother	Birtle, Bury	Cob House	Birtle.		
205	Moscrop Brothers	Wolstenholme, Rochdale	Red Lumb	Wolstenholme.		
206	John Newby	Millhouses, Hornby, Lancaster.	Smear Hall	Wray-with-Botton.		
207	Peter Nightingale and Co.	Worsley, Manchester	Mesne Lea	Worsley.		
208	Norley Hall Co.	Coppull, Chorley	Coppull Hall	Coppull.		
209	Oldham, Middleton and Rochdale Co. (Limited)	Edge Lane, Oldham	Bankhouse	Crompton	1	1
210			Sholver	Ditto.		
211			Boarshaw	Middleton.		
212			Hopwood	Ditto.		
213			Hanging Chadder	Rochdale.		
214			Low Crompton	Ditto.		
215			Hartford	Oldham.		
216			Jubilee	Crompton.		
217			Lee	Chadderton.		
218			Robin Hill	Oldham.		
219	John Parkinson Parke	Withnell Hall, Chorley	Withnell	Withnell.		
220	Wm. Thornton Parks	Bury	Elton	Elton	1	1
221	Andrew Peake	Horwich, Bolton	Wildersmoor	Horwich.		
222	Wm. Pickup	Over Darwen	Pole	Over Darwen.		
223	Joseph Place	Ditto	Hoddlesden	Hoddlesden.		
224	Thos. Ramsbottom and Sons	Birtle, Bury	Birtle Dean	Birtle.		
225	William Ramsden	Tyldesley	Messhing Trees	Tyldesley.		
226			Shakerley	Shakerley.		
227	Ralph Rawstron	Whitworth, Rochdale	Bridge Mills	Whitworth.		
228	Ditto	Bagslate, Rochdale	Old Clap Gate	Bagslate.		
229	Rawstrons and Stott	Littleborough	Rake Pottery	Littleborough.		
230	Rochdale Brick and Tile Co. (Limited).	Summit, Littleborough	Chelburn	Summit.		
231	John Rosbottom and Sons	Heath Charnock, Chorley.	Rawlinson	Heath Charnock.		
232	Ditto	Rumworth, Bolton	Victoria	Rumworth.		
233	James and William Roscoe	Little Hulton, Bolton	New Lester	Tyldesley.		
234			New Watergate and Peel Hall.	Little Hulton.		
235	Roscow and Lord	Rochdale	Chadwick Hall	Rochdale	2	3
236	Ditto	Ditto	Crow Nest	Milnrow.		
237	Ditto	Farnworth, Bolton	Stonehill	Farnworth.		
238	Peter Rothwell	Denton, Manchester	Denton	Denton.		
239	Rylands and Sons	Radcliffe, Manchester	Cockey Moor	Black Lane	2	4
240	Schofield & Co.	Smallbridge, Rochdale	Dearnley	Smallbridge	1	2
241	Jethro Scowcroft	Bolton	Tonge	Bolton	1	1
242	Samuel Scowcroft	Kearsley, Bolton	Kearsley	Kearsley	2	2
243	Ditto	Burnden, Bolton	Rose Hill	Burnden	1	1
244	John Seddon	Darcy Lever, Bolton	Top o'-th'-Meadow	Darcy Lever.		
245	Thomas Shaw and Sons	Haughton, Manchester	Haughton	Haughton.		
246			Haughton Green	Ditto	1	1

List of the Owners and Collieries in the Manchester District, &c.—*continued.*

Number.	Owners.	Address.	Collieries.	Where situated.	Fatal Accidents.	Lives lost.
247	Sheep Bank Co.	Littleborough	Sheepbank	Littleborough.		
248	Shorey Bank Co.	Over Darwen	Shorey Bank	Over Darwen.		
249	Eccles Shorrock, Brothers and Co.	Ditto	Dogshaw	Ditto.		
250			Jacks Kay	Ditto.		
251	Thomas Simpson	Blackburn	Lower Darwen	Lower Darwen.		
252	Thomas Simpson and Co.	Oswaldtwistle Collieries, near Accrington	Aspin	Oswaldtwistle.	1	1
253			Belthorn			
254			Broadfield			
255			Duckworth Hall			
256			Mossfield			
257			Stanhill			
258	John Smith, jun., and Co.	Great Lever, Bolton	Great Lever Works	Great Lever.		
259	Smithson and Butterworth	Facit, Rochdale	Hudclough	Facit	1	1
260	John Speakman	Westleigh, Manchester.	Broadfield	Westleigh	2	2
261	Stand Lane Co.	Radcliffe	Stand Lane	Pilkington.		
262			Whitefield	Pilkington.		
263	Exors. of John Stanley	Failsworth, Manchester.	Moston	Moston	1	1
264	James Stott	Kearsley, Bolton	Unity Brook	Kearsley.		
265	Richard and William Stott	Rochdale	Ashworth	Ashworth.		
266			Butterworth Hall	Milnrow.		
267			Tunshill	Ditto.		
268	Stott, Bamford and Co.	Wardle, Rochdale	Birch Hey	Wardle.		
269	James Taylor	Bacup	New Barn Brickworks.	Bacup.		
270	Thomas Temperley	Todmorden	Clough Head Brickworks.	Dulesgate.		
271	Tetlow, Lees, and Kershaw	Littleborough	Sladen Mills	Littleborough.		
272	Townsend and Co.	Greaves Collieries, Bacup	Britannia	Bacup.		
273			Greave	Ditto.		
274			High Houses	Ditto.		
275			Sharneyford	Ditto.		
276	Edward Turner	Birtle, Bury	Openshaw	Birtle.		
277	Turton Moor Co.	Turton, Bolton	Turton Moor Brickworks.	Turton.		
278	Samuel Tweedale	Rochdale	Tonnacliffe	Tonnacliffe.		
279	Jacob Tweedale and Sons	Ditto	Healey Hall Bottoms.	Healey Hall.		
280	Tyldesley Co.	Tyldesley	Tyldesley	Tyldesley.		
281			Combermere	Ditto.		
282	Eli Walsh	Over Darwen	Heyfold	Over Darwen.		
283	Thomas Whaley	Blackrod, Chorley	Blackrod	Blackrod.		
284	The Whitaker Co.	Whitaker, Littleborough.	Whitaker	Whitaker.		
285	Thomas Whittle	Blackrod, Chorley	Marklands	Blackrod.		
286		Chorley	Duxbury and Chorley.	Duxbury. Chorley.		
287	Charles Whowell	Two Brooks, Tottington, Bury.	Monk's Bank	Quarlton.		
288	Wigan Coal and Iron Co. (Limited.)	Westleigh, Manchester.	Nos. 1 and 2	Westleigh	1	1
289	John Sutcliffe Witham	Hapton, Burnley	Hapton	Hapton.		
290	John Woodhead	Waterfoot, Manchester.	Intake	Brandwood Moor		
291	William Woods and Son	Blackrod, Chorley	Scot Lane	Blackrod.		
292	Exors. of John Wright	Little Hulton, Bolton	Bank	Little Hulton	1	1
				Total	61	65

I have, &c.
(Signed) Joseph Dickinson,
Inspector of Coal Mines.

The Right Hon. Henry Austin Bruce, M.P.,
Principal Secretary of State,
Whitehall.

Mr. Higson's Report.

REPORT of the WORKING of the MINES INSPECTION ACT (23 & 24 Vict. c. 151.) in the WEST LANCASHIRE and NORTH WALES DISTRICT, during the Year ended 31st December 1868.—By PETER HIGSON, Esq.

SIR, Swinton, Manchester, February 28th, 1869.

I HAVE the honour to transmit the following Report of my proceedings as Inspector of the Mines of coal and ironstone in the District comprising South-west Lancashire and North Wales during the year 1868.

The period to which the following observations refer was one of great and unusual calamity, which will be long and deeply regretted. It began by a three months' strike of the coal miners of South-west Lancashire, during which all mining operations in that locality were entirely suspended, and it terminated with a succession of such deplorable casualties and loss of life as had not for years before happened in the District.

While investigating the character and origin of many of these serious accidents, I was much impressed with their connection with other events, past and present. The long strike, the stagnation of trade, the excitement of the times, and the county and borough elections also, caused the workings to be in some measure neglected, and the workpeople to become idle, careless, and in fact demoralized. When the time for active exertion arrived, everybody and everything was out of tune; the works required carefully handling, but the head and hand of the workman had forgot their cunning, and then followed those disasters which I shall attempt herein-after to describe.

The number of lives lost in the year 1868 is greater than that in the year 1867 by 103, and the number of fatal accidents by 8.

This large increase in the loss of life has been caused principally by the explosions of fire-damp at the Wynnstay Colliery near Ruabon, the Hindley Green Colliery near Wigan, the Haydock Colliery near St. Helen's, and at the Norley Colliery, in Pemberton near Wigan, by which in the aggregate 106 persons were killed. From many other causes also loss of life has too often happened, very frequently, I regret to say, from ignorance or negligence, and occasionally by misadventure.

The casualty at the Wynnstay Colliery, which will be found herein-after more particularly described, occurred through inadequate supervision of the workings; the Hindley Green catastrophe happened primarily from the same cause, combined with the unskilful firing of a shot. The working and adjoining places of the Haydock Colliery could not have been carefully examined by the fireman on that fatal day, or the gas which exploded would have been found, and its safe removal required no unusual skill: that it was ignited by the firing of a shot in the adjoining place there can be no doubt. In the case of Norley, the fireman carried his own life and the lives of seven others, then in different parts of the mine, in his own hands. He was employed to make a careful examination of all the working places of that particular district of the workings every morning, before the workpeople entered therein. The result shows clearly that no such inspection had been made.

In all these lamentable occurrences, except only that at Ruabon, the fireman perished with the rest. Not a soul therefore was left to tell the state of things in the mine below, on the morning of those fatal days. The fireman of the Ruabon Works stated in evidence that he made an inspection of the place in which the gas had or was supposed to have accumulated, early on that morning, and found it then clear of gas, and, as usual, safe; there was however some discrepancy in his evidence. The time when such inspection was said to have been made, and that of his being seen in other places, was too short to have enabled him to do so in a proper manner, consequently his evidence had little or no weight with the jury.

These facts have contributed largely to show the character of the class of men on whom we have to rely in a great measure for the safety of our coal mines. That in the number employed there are many trustworthy men, I willingly admit; but there are a great number who are ignorant of their business and who are, if not reckless actually, negligent and unthoughtful. Many, I may say a majority, can neither read nor write, though such are not, generally, the least to be relied on. Intemperance is one great and primary cause of incapacity and neglect, and to it may be traced the origin of many casualties. The close proximity of beer houses to the mines and works under consideration is an evil which loudly calls for legislative interference.

It may be argued that the owners of mines should employ more competent men to act as firemen. But such men are scarce in this district. Within the last 10 years the out-turn of coal has been nearly doubled; this has caused a great number of strangers to be employed, strangers not only to the workings of these mines, but to the dangers by which they are surrounded, from gas, &c., and whose characters for skill, sobriety, and care are unknown. The best colliers also can now get higher wages than formerly, and consequently prefer getting coal to being employed as firemen, which would take them from home at a much earlier hour in the morning. This scarcity will continue till such times as a class of young and better educated men have been trained for the office, and are capable of efficiently discharging the various and important duties which the nature of the appointment invariably requires.

I find, however, that firemen are frequently compelled to act as labourers by filling up their time, after having made an inspection of the working places of the men, in dressing roads, &c., and other ordinary occupation. This has an injurious effect on the discipline of the people employed. To some extent it lowers the position of the firemen, and thereby lessens their authority over the men, and diminishes the opportunities they would otherwise have of properly considering their duties, and making constant alterations and improvements in the works. It is somewhat different with assistant firemen, but their extra duties should never extend beyond fixing brattice to keep the current of air up to the extremity of the working places. A great number of these men can neither read nor write, and their general tone and character is seldom above that of the average of the working colliers; while in some cases the underlookers are little, if any, superior in any respect to the firemen.

Energetic and unwearied efforts are, however, being made to alter this state of things. A great number of very excellent schools have been built, and competent schoolmasters appointed, in almost every part of the district, by the owners of the mines and collieries, some of which are now nearly self-supporting. Nearly all the employers of labour now prohibit boys under the age of 12 years working below ground, and though that restriction may be sometimes evaded, it is upon the whole pretty well enforced; and it is now an ordinary thing to find a school containing from 50 to 100 boys of all ages from 12 years downwards. This must manifestly be preparing the rising generation for the battle of life, if not in the very best manner possible, at least very satisfactorily; and that the system now so well established will go on, and, like a sapling well planted, gain strength and vigour from year to year, till it becomes a tall and majestic tree, is much to be desired. I have no favourable report to give of the state of adults, they are much the same as they were a dozen years ago, both males and females; and no tangible improvement need be expected, inasmuch as none will, in my opinion, ever take place. It cannot, however, be considered that the system of primary education is properly established while that of females is all but ignored; hundreds of untaught girls are daily employed on out-door labour, for which the law makes no provision. They contrive, in some instances, to gather, as it were, the crumbs of education which the boys wantonly scatter; and in many of the first class schools, like those of Haigh, Haydock, Park Lane, and in Ince, they are well provided with the means of learning; in all these places, except one of the schools in Ince, by the benevolence of the colliery owners, who take proper interest in the welfare of the children of their workpeople; but where the owners have not provided schools, the age and education of boys only are observed.

Although I am still of opinion that the Act is working satisfactorily, the existing provisions require in this respect a little amendment. The enactment that requires the attendance of a boy under 12 years of age two days a week at school, 3 hours each day, prevents him from going to work on those days, which would cause him to lose his employment. This deprives a widow with a large family of the means of realizing an income from the labour of her children in many instances; so that I am of opinion that if the time of attendance at school was altered to 3 days a week, and the hours for each lesson from 3 hours to 2, the value of the measure would be greatly improved.

Mr. Johnson, one of the Inspectors of Schools, having stated, in his report for the year 1867, that in South-west Lancashire the Act, so far as it relates to the education of children of tender age, was not strictly observed, I received instructions from the late Secretary of State, the Right Honourable Gathorne Hardy, to make strict inquiries as to the same, and to report thereon. Pursuant to his request, I visited all the principal schools in the district, and thereby traced the rumour back to its source. I found that in some instances the provisions of the Act had been ignorantly violated; in others the schoolmaster, not knowing the Act, had given certificates of irregular attendance, summing up the number of hours of attendance for the week, but in every case to boys beyond the age at which a certificate can be demanded. This irregularity prevailed more in dissenters' schools than in those connected with the Established Church, although the children are equally well taught there. At the Roman Catholic schools in and about Wigan I found a great many boys in attendance who had passed the age of 12 years. In all cases I was agreeably surprised to find that so much had already been done, and that improvements were still progressing most satisfactorily for the future welfare of the rising generation. There is, however, still great scope for the benevolent, plenty of unexplored ground, to reclaim, thousands of unemployed who cannot read, wanderers in the streets and lanes till the time arrives when the Act empowers them to begin to work in the mines. Many of these will never, perhaps, fall into the way of earning an honest living by their own industry, but will remain through life outcasts from the lower stratum of society, even though they do not sink still lower than that, and become criminal characters. This state of things proves beyond all question of doubt, that unless education be made compulsory generally, we shall still have a large population of ignorant labourers, intemperate, immoral, and unmanageable; and this will be promoted by the decision of many of the large mine owners, who now refuse to employ boys under the age of 12 years.

For the purpose of raising the standard of the management of mines, it is necessary that the underlookers and firemen should be trained for the better discharge of their duties, for which, at present, no provisions have been made. Some years ago a mining school was established at Wigan, but it has made little or no progress. The lectures given there have been scientific, not practical, and to the sons of those persons who could obtain instruction in other places No practical teaching or technical learning of the men who have to manage our mines has been attempted, so that those who stand so much in need of further information have hitherto derived no benefit from any source whatever. If the Wigan mining school were to be re-arranged, so that a number of hours in every week could be set apart for instructing underlookers and firemen to discharge more efficiently their very difficult and onerous duties, greater advantages to the owners and workers of mines would immediately accrue. Lectures on chemistry, to uneducated men, are nothing less than time wasted, as the result already proves.

It is much to be regretted that the owners of collieries do not in all cases select for underlookers and firemen a better class of men, and that they omit to have them specially trained for their duties. It still too often happens that the chief manager is not a competent miner; in such instances the under ground officers are not as a rule judiciously selected, which renders the supervision not only difficult, but defective. Proper provisions are either deferred too long, or inadequately made, the purchase of materials becomes irregular, and an honest statement of facts in due time is invariably withheld. If the chief manager of a mine has not sufficient practical knowledge, a viewer or mining engineer should be employed to superintend the working and ventilation of the same. And in all mines the underlookers and firemen should not only be able to read and write, but they should have sufficient knowledge of ventilation, of the best mode of fixing supports for the roof and sides of the mine, of opening out the same so as to remove the material thereof at the least possible cost, and with the greatest safety during present and future operations, and to acquire that authority and control over the workpeople, in the absence of which all attempt at management completely fails.

The workpeople are rough, and in many instances disobedient; they do not properly observe the provisions of the special rules. They neglect to prop and sprag the roof and sides of the mine. They descend and ascend the pit contrary to published instructions. They charge shots defectively, which frequently blow out in a vitiated atmosphere, and cause an explosion. If the roof sounds well in answer to the blow of a hammer, they neglect to prop it till it falls and causes loss of life. They run the boxes below ground at a random pace, regardless of any one being in the way, by which loss of life or serious personal injury frequently happens. They open or interfere with their safety lamps, so as to enable them to smoke below ground, which is strictly prohibited. By these and other such irregularities, such accidents as I have herein-after to describe have happened. It is seldom, however, that they have been caused by old and experienced colliers or mining men, but chiefly by strangers to the mine, or those who began late in life to follow the employment, or by the young and inexperienced. It may show a great want of discipline, but that most important element in mining is most difficult to establish and maintain. Under the circumstances, therefore, I have been induced to issue the following circular letter to all the colliery owners of the district, in order that it may be distributed and read to or by those they employ.

Inspection of Mines, South-west Lancashire and North Wales District.

(Acts 23 & 24 Vict. c. 151; 5 & 6 Vict. c. 99; and 25 & 26 Vict. c. 79.)

Circular letter, January 1st, 1869.

The number of casualties and the great and serious loss of life in and about the coal mines of this district in the year 1868 must have produced the most painful reflections.

They have placed those immediately connected therewith in an unenviable position before the public, and they have drawn the attention of all to a state of things which should cease to exist as soon as possible.

The accidents referred to herein have happened from explosions of inflammable gas and gunpowder, from shots igniting while being stemmed, from falls of roof and falls of coal, from recklessly running trams and tubs below ground, by travelling on and being at the foot of inclined planes while the machinery was in motion, from unskilful winding, from incautiously moving railway trucks above ground, and by attempting to extinguish standing fires in mines with water.

I find that firemen and coal miners neglect to fix props and sprags till the places become actually dangerous from falls. They trust to sounding the roof and sides with a hammer or pick, although they must now know that large blocks of stone will sound solid and then fall without warning. To avoid loss of life from this source almost daily caution seems necessary, props should be regularly fixed in all working places within a short distance from the face, even though the roof may appear to be safe.

The great loss of life from the unskilful use of gunpowder clearly proves that blasting in mines which emit inflammable gas should be at once discontinued for getting coal. In those mines which do not give off gas it should only be allowed under competent supervision.

In blasting, an iron instead of a wooden or copper rammer is still too often used in getting the wadding and first part of the stemming fairly bedded on the powder; shots which have missed fire are still drawn, although experience shows that, even with water in the hole, the drill goes in advance and ignites the powder. When a charge has missed fire it should not be drawn, but a second shot should be placed so near as to fire both charges. No work-person should be allowed to take down the pit more gunpowder than he will require in one day.

As brattice so frequently gets disarranged, strong objections will be raised in future to its extensive use. Although it may be indispensable for conducting the ventilation from one cut through to another on the main roads when the length is limited, it should not be made a reliable means of ventilating workings in previously unexplored ground, nor until the gas has been partially drained off by double air roads.

Many lives are lost annually on inclined planes, which has rendered the absolute necessity of preventing persons going thereon, and of preparing separate and distinct roads for them to travel on to and from their work, an obvious and unquestionable result.

I have to call your attention to a system which has recently grown into a source of evil. It is that of leaving small pillars of unworked coal too far behind the main group of workings, surrounded on three sides by the goaf: such outlying portions of coal can only be recovered under great and unnecessary risk, loss of life therefrom being of frequent occurrence. This, generally, is an unmistakable mark of bad management which should in all cases be avoided.

Several mines having recently taken fire, by unsuccessful efforts to extinguish which, many lives have been lost, I take this opportunity of suggesting for your future guidance that the safest way of putting out a fire is to prevent the access to it of atmospheric air.

I have also to call your attention to the 8th General Rule of the Act 23d & 24th Vict. cap. 151., which does not appear to have been generally observed, and to remind you that for any neglect or omission thereof, or of the special rules thereunder established, proceedings against you may be taken under the powers granted by the said Act; and

I do hereby give you notice, that I require covers to be provided and used overhead when lowering or raising persons in all working pits or shafts, except in those worked by a gin or windlass, or when sinking or attending to the pumps, or in special cases for which any written exemption has been previously obtained.

Peter Higson,
Inspector of Mines.

Swinton, near Manchester.

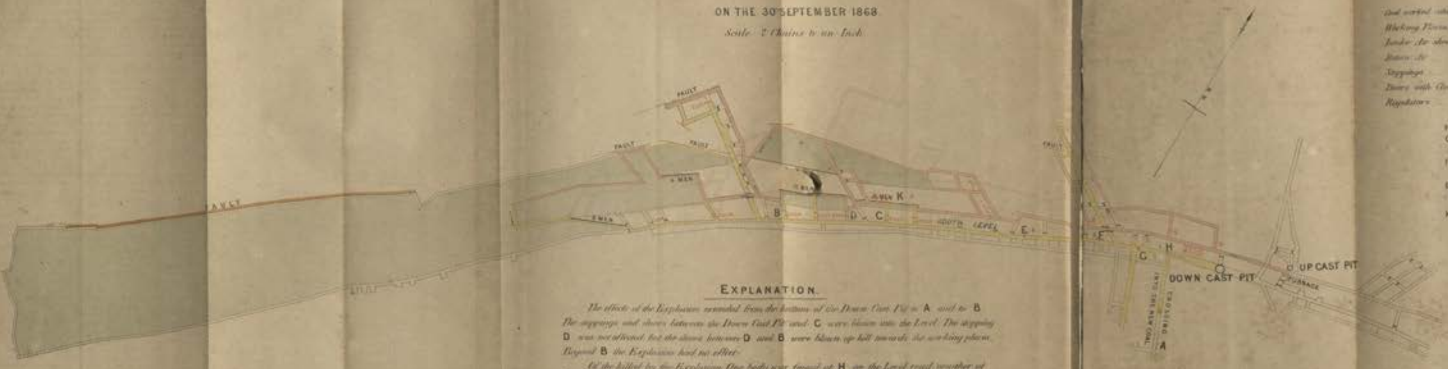
Plate 1.

WYNNSTAY COLLIERY NEAR RUABON

PLAN SHEWING VENTILATION IN THE MAIN COAL, SOUTH LEVEL, AT THE TIME OF THE EXPLOSION

ON THE 30th SEPTEMBER 1868.

Scale 2 Chains to an Inch.


FAULT
FAULT
FAULT
FAULT
FAULT
4 MEN
2 MEN
3 MEN
4 MEN
K
B
D
C
SOUTH LEVEL
E
F
G
H
DOWN CAST PIT
UP CAST PIT
FURNACE
CROSSING INTO THE NEW COAL
A
N

REFERENCE

Coal worked since last time	🟩
Working Places	▬
Intake Air shewn thus	🟨
Return Air	🟥
Stoppings	⊥
Doors with Cloths at back	⊥⊥
Regulators	⊥

H 1	*Thomas Ward*	*Suffocated*
C 2	*Henry Davies*	*Killed*
	John Pearson	*Suffocated*
F 3	*Moses Andrew*	*D°*
	David Roberts	*D°*
E 4	*John Lloyd*	*D° & slightly burnt*
	James Davies	*D°*
K 5	*Hugh Edwards*	*D°*
	Edmund Edwards	*D°*
	Meshach Jones	*D°*

EXPLANATION.

The effects of the Explosion extended from the bottom of the Down Cast Pit to A *and to* B. *The stoppings and doors between the Down Cast Pit and* C *were blown into the Level. The stopping* D *was not affected but the doors between* D *and* B *were blown up hill towards the working places. Beyond* B *the Explosion had no effect.*

Of the killed by the Explosion One body was found at H *on the Level road, another at* C, *three at* F, *another at* E, *and Four in the working places* K.

Three burnt were on the Level between the Down Cast Pit and H, *and One in the Crossing at the New Coal.*

1 Engine house, 2 [illegible] Feeder house with 14 yards [illegible] between [illegible] and [illegible] between pillars air courses & stopping being put up at the time of Explosion.

In the early part of the year a remarkable accident happened at the Afon-ietha Colliery, near Ruabon in Denbighshire, in consequence of the non-observance of the Act 25th & 26th Vict. cap. 79., which requires two entrances to every mine. A second shaft had been once provided and suffered to close, so that at the time in question there was only one pit or shaft in use; this also collapsed while several men were in the workings below. Luckily, all but a man and a boy were got out safely in good time, but these poor creatures were entombed alive, and after being confined in the workings for eight days they were safely recovered, and are now living. At the time this occurred I was confined to bed, so that the investigation was made by my colleague Mr. Dickenson, and by him proceedings were taken against the owner for having committed a breach of the before-mentioned Act, when a penalty was recovered.

A somewhat similar accident happened at the Mesnes Colliery in the borough of Wigan, but unfortunately three lives were lost. They were engaged making improvements near the eye of the pit, when they were suddenly killed by an unexpected fall from the roof and sides. This, however, appeared to have been an unforeseen accident, for which previous provisions to avoid could hardly be expected.

Explosions and Loss of Life:—Swan Lane Colliery.

This explosion, which caused the death of one man, and of two others who perished in the after-damp in attempting his rescue, happened in the extreme rise workings of the four-feet mine at the above colliery. Charles Abbott, a collier, who was sent to the top of a jig-brow by the underground manager, went into his own working-place beyond, and having a naked light he fired some gas which, for want of brattice, had accumulated therein; an explosion took place which caused his death. The underground manager and two others heard the explosion, and went into the foul air to get him out. The two men were suffocated in the after-damp, but the manager was rescued, and, although insensible many hours, subsequently recovered. In this instance, care should have been taken to replace the stoppings, and, by means of brattice, remove the foul air before they went into the place. Proceedings were taken against the owner under the provisions of the Act, for having neglected to observe the first general rule, by which a penalty of 5*l.* was recovered. There was manifestly a conspicuous absence of discipline at the works, and the management was ineffective. A crowd of noisy, rude, and apparently intemperate fellows surrounded the inquest room during the inquiry, seemingly with the object of misdirecting the course of justice.

Wynnstay Colliery.

On referring to the plan annexed of the workings of this mine, it will be observed that on the south side of the pit, in the main coal seam, three up-brows have been driven towards the rise or outcrop thereof within a short distance of the pit eye. They were ventilated by a split of air from the main inbye current going along the horse road below, and borne to the top by doors and stoppings placed in the end ways, by which at intervals they were connected. In the second level or end way from the bottom a door had been in existence for some time, but it was removed a few days before the explosion. On that unfortunate day a bricksetter was employed to build a brick stopping in its place. Immediately after the stopping was completed the explosion took place, which caused the death of 10 persons, all of whom were found near the eye of the pit quite dead. It is manifest that the places in question must have been rendered foul during the time the door was absent, as the wind would go the shortest way to the upcast pit for that period; that on the stopping being completed it was again forced up the brows, when gas, which must have accumulated there, was removed by the current, and that in passing away it came in contact with flame, by which it was ignited, which caused the explosion. I found numerous sparks issuing from the furnace, which was fed with fresh air; but any other flame on or near the air-course could not be discovered or traced to have been there at the time. Two day-wage men had been there a short time before the explosion, but they worked with lamps locked and safe. They were on the other side of the pit at the time, and received no injury. The inquiry was long and searching; great efforts were made to ascertain how the gas was ignited, but they completely failed, so that it is still enveloped in a cloud of mystery. I have, however, after mature deliberation, come to the conclusion that some of the deceased persons must have gone through the doors near the eye of the downcast pit into the return air-course, and there, perhaps for the purpose of smoking, exposed a naked light, which was proved to have been done before, and there ignited the gas which must have been passing at the time to the upcast pit. But I could not overlook the fact of sparks issuing like strings or ropes of fire from the furnace into the foul air in the upcast shaft, the danger of which

I pointed out to the manager, together with many other improvements, including that of another pit or shaft, some of which are now nearly completed, and the rest under consideration. The fireman told the jury that he had examined and found the up-brows safe on the morning of the casualty, but that statement could hardly be relied upon, inasmuch as it was not supported by the evidence of several trustworthy witnesses; my own impression being that those places had not been visited for some time by any one. As there was no trace of burning in or near the upcast pit, the gas, I think, could not have been ignited by anything that came from the furnace. Safety lamps were used below ground.

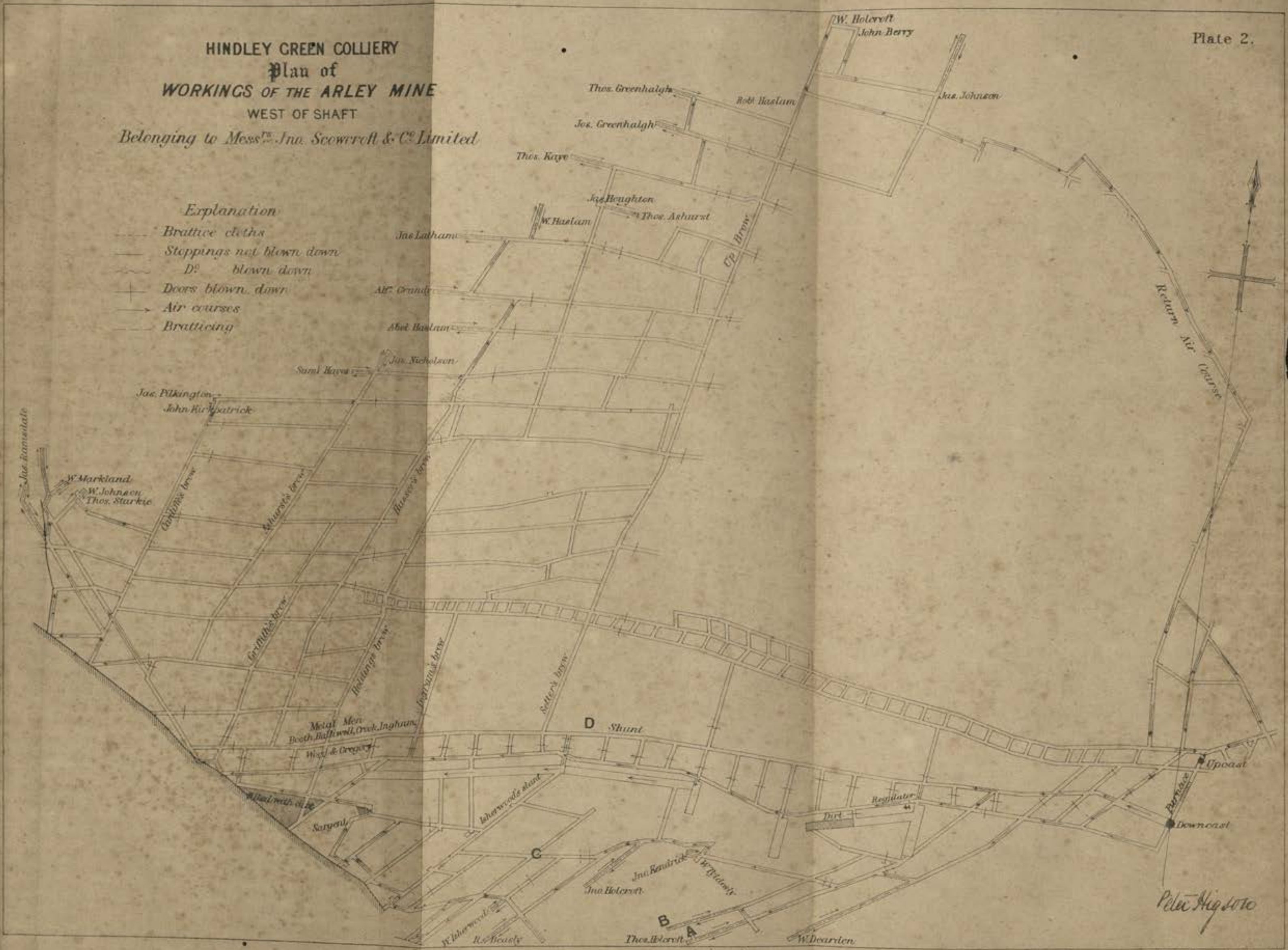
Haydock Colliery.

This casualty, which caused the death of 26 persons, happened in the 9-feet mine of this colliery on the day mentioned in the list of accidents hereunto annexed. The plan attached to this report shows the limited extent of the workings, which were only being opened out at the time to prepare for a more approved system of working and conducting the ventilation. Although the mine makes gas, it cannot correctly be called fiery, or be worked without the use of gunpowder. This explosion, in addition to the loss of life, did a considerable amount of damage; besides falls of roof, and the destruction of doors and stoppings, the flame was severely felt more than 900 yards from the spot where the gas was evidently ignited, by, as was satisfactorily ascertained, a blown-out shot. One of the colliers, as I found, had drilled two holes into the same block of coal; the first had not removed the coal, the second appears to have blown out, which would produce great flame, and whether it ignited some gas in the end-way above, or, by a readjustment of the brattice gas, was being removed therefrom into the road below, where the shot was being fired, there was nothing to show. But the fireman, who was found among the dead, was apparently returning from that part of the workings, and was supposed to have found the brattice down, and by putting it up without due consideration as to the result, turned the air upon the gas accumulated in the place marked B. on the plan, and thereby drove it into the place marked A. below, and that it was passing through it at the time the shot was being fired by one of the deceased. The place B., in which I am confident gas had been accumulated, had been standing some time, and the ventilation of the same conducted by brattice. It was a sound and natural conclusion to draw from these facts that the brattice had been down, that gas had accumulated in consequence; that as no one had been working in the place for some time, it had not been examined daily by the fireman, as required by the rules of the colliery; and that the gas was not known of by him, and that it was ignited either in one or other of the two modes herein described. These frequent casualties have disclosed the painful fact that firemen have omitted to make an inspection of places not in actual work, although situate near those workings in which men are daily employed: this shows a serious neglect of duty, into which the owners of mines should make constant and minute enquiry, and provide a check on their proceedings, whereby any neglect or omission may be detected to prevent accidents occurring. It having recently become the practice to conduct the ventilation of workings by means of brattice cloth to a considerable extent, on the grounds no doubt of economy, though some allege of safety in the event of an explosion taking place, the system cannot be allowed to go on, nor be too soon discontinued. Brattice makes but a delicate and unreliable partition, as it is liable to be broken down by the slightest fall from the roof; it requires constant and unremitted attention on the part of every one in any way connected with the working of a mine, which experience shows is seldom or never given in the manner and form absolutely required. It did not appear that the underlooker of this mine had inspected the place in which the gas was fired for some time previously, relying on the fireman seeing that it was safe. Two days before a collier was sent to make a cut through into the parallel road from B. to A., but he did not go to the end by 10 or 12 yards. Neither the underlooker nor the fireman went with this man, who was a stranger to the mine, and ignorant of gas and the mode of dealing with it. He was absent on the day of the explosion, and thereby escaped the catastrophe. The owners of this mine would do anything to prevent such a casualty as this, and I have always believed the colliery to be exceedingly well managed. In opening out large areas of new ground it is a great mistake to conduct the ventilation by means of brattice, except only from one cut through into a parallel road to another, which should not in any case exceed 20 yards, and in no instance should bratticed places be suspended until they have been opened out at the extreme ends, and communications made with the adjoining place or places, so that the ventilation may be free from risk. To leave endways or other places depending for their ventilation on brattice is in all cases to provide the means of a casualty sooner or later, which the facts contained in these pages prove beyond any question and doubt; and such practices will not be passed unnoticed.

Plate 2.

HINDLEY GREEN COLLIERY
Plan of
WORKINGS OF THE ARLEY MINE
WEST OF SHAFT

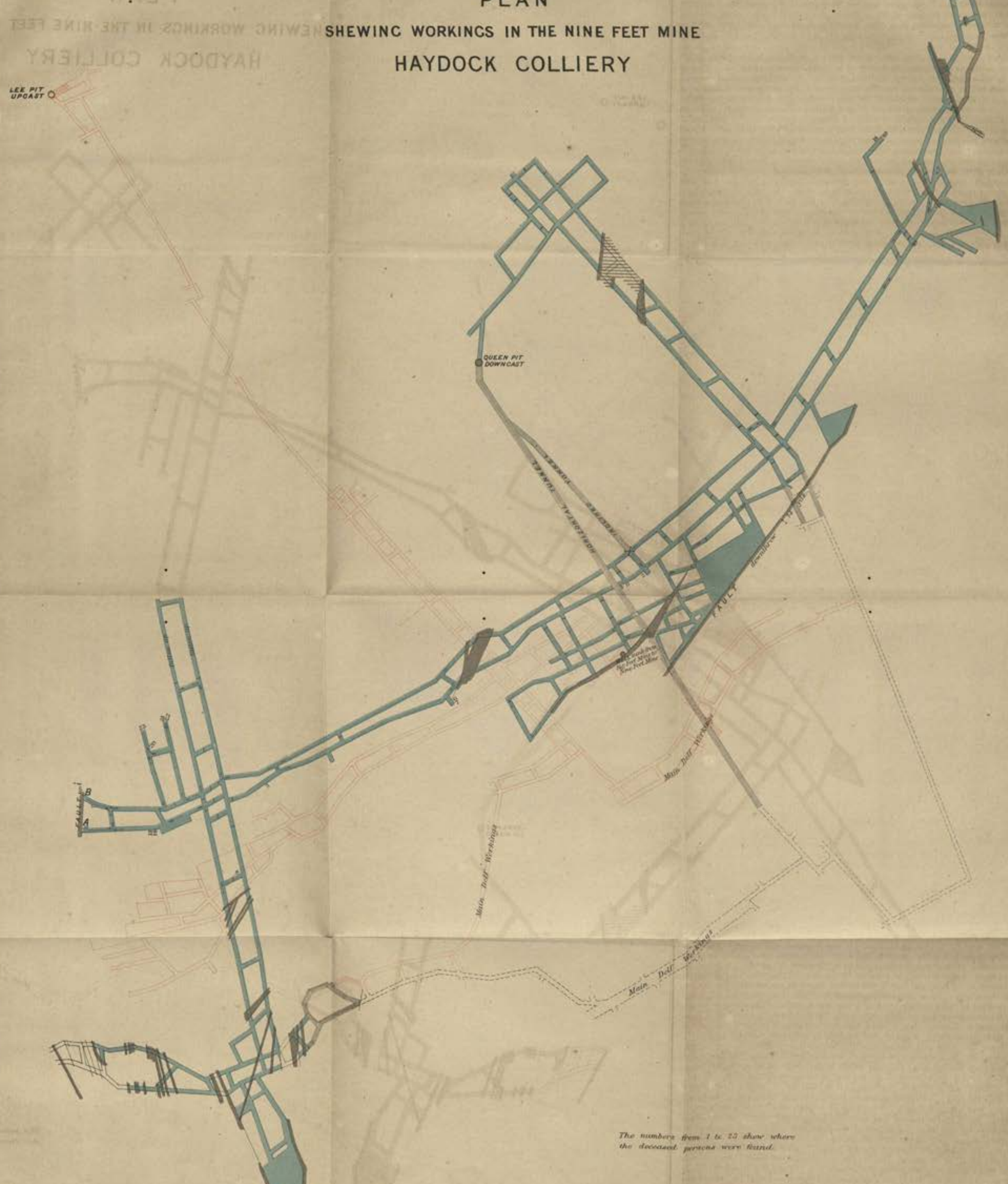
Belonging to Mess^rs. Jno. Scowcroft & C^o. Limited


Explanation
Brattice cloths
Stoppings not blown down
D^o. blown down
Doors blown down
Air courses
Bratticing
W. Holcroft
John Berry
Thos. Greenhalgh
Robt. Haslam
Jas. Johnson
Jos. Greenhalgh
Thos. Kaye
Jas. Houghton
Thos. Ashurst
W. Haslam
Jas. Latham
Up Brow
Alf^d. Grundy
Abel Haslam
Jas. Nicholson
Saml. Hayes
Jas. Pilkington
John Kirkpatrick
Return Air Course
Jas. Ramsdale
W. Markland
W. Johnson
Thos. Starkie
Collins's brow
Ashurst's brow
Hasser's brow
Griffith's brow
Holdings brow
Ingham's brow
Setter's brow
Metal Men
Booth, Balliwell, Crook, Ingham
Wood & Gregory
D
Shunt
Filled with dirt
Sargent
Isherwood's slant
C
Jno. Kendrick
W. Tyldesly
Jno. Holcroft
Regulator
Dirt
Upcast
Furnace
Downcast
W. Isherwood
R. Beasly
B
A
Thos. Holcroft
W. Dearden

Peter Higson

Vincent Brooks, Day & Son, Lith.

PLAN
SHEWING WORKINGS IN THE NINE FEET MINE
HAYDOCK COLLIERY


LEE PIT UPCAST
QUEEN PIT DOWNCAST
HORIZONTAL TUNNEL
FAULT
FAULT
Downthrow
Ten Feet Mine to
Nine Feet Mine
Main Delf Workings
Main Delf Workings
Main Delf Workings
A
B

The numbers from 1 to 23 show where the deceased persons were found.

Scale 48 Yards to One Inch

N.B. Workings in the Nine Feet Mine colored Blue

Peter Higson

Hindley Green Colliery, Wigan.

This explosion took place in the Arley mine, a well known fiery seam, and caused the death of 62 persons. I arrived there on the day of the casualty, before the deceased were got out of the mine. I made many subsequent inspections of the same, and attended the coroner's inquest on the deceased, which was extended over six days. The verdict of the jury failed to fix responsibility: it was a sort of open verdict, aiming as it were at something beyond, which it omitted to express; but it condemned the practice of blasting the coal with gunpowder, which has since been discontinued. It manifestly happened within a few hundred yards of the downcast pit, and on the deep side of the horse road level, where the heat and flame left its marks on the roof and pillars of unworked coal unmistakeably. On the Rise, and in undoubtedly the worst ventilated districts of the mine, men who were working there came out uninjured, while on the other side of the pit the explosion was scarcely heard. The scene and origin of this disaster were to be easily traced to two slants which were being driven down hill by one of the deceased, Thomas Holcroft, a collier of no great ability, who seems to have had little or no experience in the use of gunpowder. He had worked in both these slants, and on the day of the explosion he was making a cut through from one to the other, and was working at the time in the lower one, at the point A on the plan, the other having been suspended for some time. Both were giving off gas rather freely, the top slant B. from the floor, face, and sides; the lower one at the face only; and the ventilation of both was at the time conducted for many yards by brattice. In the lower or bottom slant at A, I found a shot hole which had been charged, and the charge had been blown out, but the coal had not been disturbed. In the upper or top slant the sides and roof had been marked by fire, which could be traced more or less distinctly for a very considerable distance in the direction of the in-bye current of air, until at the place in which William Isherwood worked, at the point C., it appeared to have been most intense, and to have exploded there. At this point an empty powder can was found, in which gunpowder had no doubt been exploded. Some of the witnesses attributed the disaster to that cause, but subsequent inquiries brought out the facts that Isherwood could not have had so much as one pound weight of gunpowder in the can, and at most the can would not have held more than two pounds. As this cause seemed too ridiculous to be maintained, it died away in an echo. There can be little or no doubt that some gunpowder was ignited, but for the primary cause an accumulation of gas only could be assigned. After many a careful examination of the workings, I was obliged to return to the place first identified as that in which the gas had been accumulated, and where it was ignited, viz., in Thomas Holcroft's old place, or the top slant or end way shown on the plan hereunto annexed at B.; that place was giving off gas freely, and having been stopped for some time, gas would be accumulated if the brattice happened to be down, and from the traces of fire there it must have been so. When Thomas Holcroft fired the shot in the place below, it would, in consequence of not blowing down the coal, produce great flame, which would so expand as to reach and ignite the gas in the place above; and that being once ignited would go on burning so long as the air was inflammable, and on meeting with a supply of fresh air a little beyond Isherwood's place, it would as a natural consequence explode: that this been the course of events I have now no reason to doubt. The travelling flame of burning gas would in all probability ignite the gunpowder, and cause the death of some of the unfortunate men from actual burning, but the majority died from suffocation in the after-damp which was much stronger than any reasonable quantity of gunpowder could have produced, while the flame from the latter would not have extended a tenth part of the distance, as it had evidently travelled in this instance. The workings under consideration could not have been properly inspected that morning by the fireman, or, if they had, the gas must have been found by him. It could not have accumulated in the time that had elapsed between the hour of inspection and that of the explosion. It was on the day following the election for South-west Lancashire, on which the works were suspended, and a great deal of drinking going on in the neighbourhood, in which the fireman, John Highton, generally a sober man, joined. He returned home at eleven at night, quarrelled with his wife, and what he did after that hour is still only imperfectly known, but at the proper hour the following morning he was seen by the underlooker, and then reported to him that all the places were safe. A fair and reasonable quantity of air appeared to have been going through the workings generally, but this particular district could not have had any surplus quantity. When the workings were suspended a less quantity was capable of diluting the gas, but as they are finally stopped I have no means of testing it under other circumstances. All the care that could be taken by the manager, in the use of safety lamps, the employment of the underground officers, and the provision of materials, had been judiciously exercised; but the mode of opening out the workings was of too bold a character to admit of my discovering that ordinary skill had been sagaciously applied in that department of the engineering of the works: still it was only a copy of the proceedings of some neighbouring mines, which has recently come into existence, but which cannot be too soon abandoned. These workings, which were only being opened out, have a range of strait work extending over 22 miles (see tracing of plan). Many of the deceased persons were found on the waggon road (see plan, D.), and in the openings on the south side below; only a few were burned, the rest were suffocated in the after-damp. The colliery had a good reputation among the workpeople for being well ventilated, and for the honest liberality of the firm, so that great sympathy was shewn them. This is another painful instance of the uncertainty of depending too much on ventilating by brattice cloth, instead of driving double roads, particularly in opening out mines, and of omitting to have places that have been stopped or suspended carefully examined daily. Much was written and talked about the barometer and the manner in which atmospheric changes affect the ventilation of mines and promote the escape of gas. In admitting the accuracy of such statements, I may here observe how ridiculous it seems to attribute the origin of explosions in mines to such causes, when there is sufficient evidence exhibited so plainly to prove the most gross neglect. The barometer was rising, and had been for two days, when this casualty happened.

Norley Colliery.

This explosion in the Orrell four-feet or Orley mine happened on the Monday following the pay day, when the general operations of the mines were suspended. Elijah Cheetham, fireman in charge of the workings in question, was ordered, being an idle day, to level the floor of the mine over a step in one Dauber's place, at A. on the plan, and was told at the time by the underlooker that the use of gunpowder would not be necessary, as it was soft. As Cheetham and his assistant went to their work, they had to pass by some men who were working near the eye of the pit, at B on. plan, from whom they obtained some gunpowder, which, contrary to instructions, they appear to have used. In a short time after they went in the explosion took place, which caused the death of eight persons, besides doing such injury to the workings, so that some time elapsed before I could complete my inspection of all the places. Subsequently I found that Cheetham had fired a shot, which appeared to have caused the explosion. It had left unmistakeable traces on the roof of the mine, and on the pillars of unworked coal, and it was proved by several trustworthy witnesses that the flame had actually entered the shaft 550 yards from the seat of the explosion. It was Cheetham's duty to have made a careful inspection of all the workings as soon as he got there, and more particularly on this than on ordinary occasions, as the furnace had been out, undergoing repairs, from the Saturday previous until the Sunday afternoon. If such inspection had been made, he must have found the gas which had evidently accumulated. About 14 persons only are employed generally in this district, and the quantity of air produced for the ventilation thereof may be taken at 6,000 cubic feet per minute. The mine gives off gas, but not very freely or in large quantity. Here again, as at the Wynnstay and Hindley Green Collieries, careful supervision was neglected.

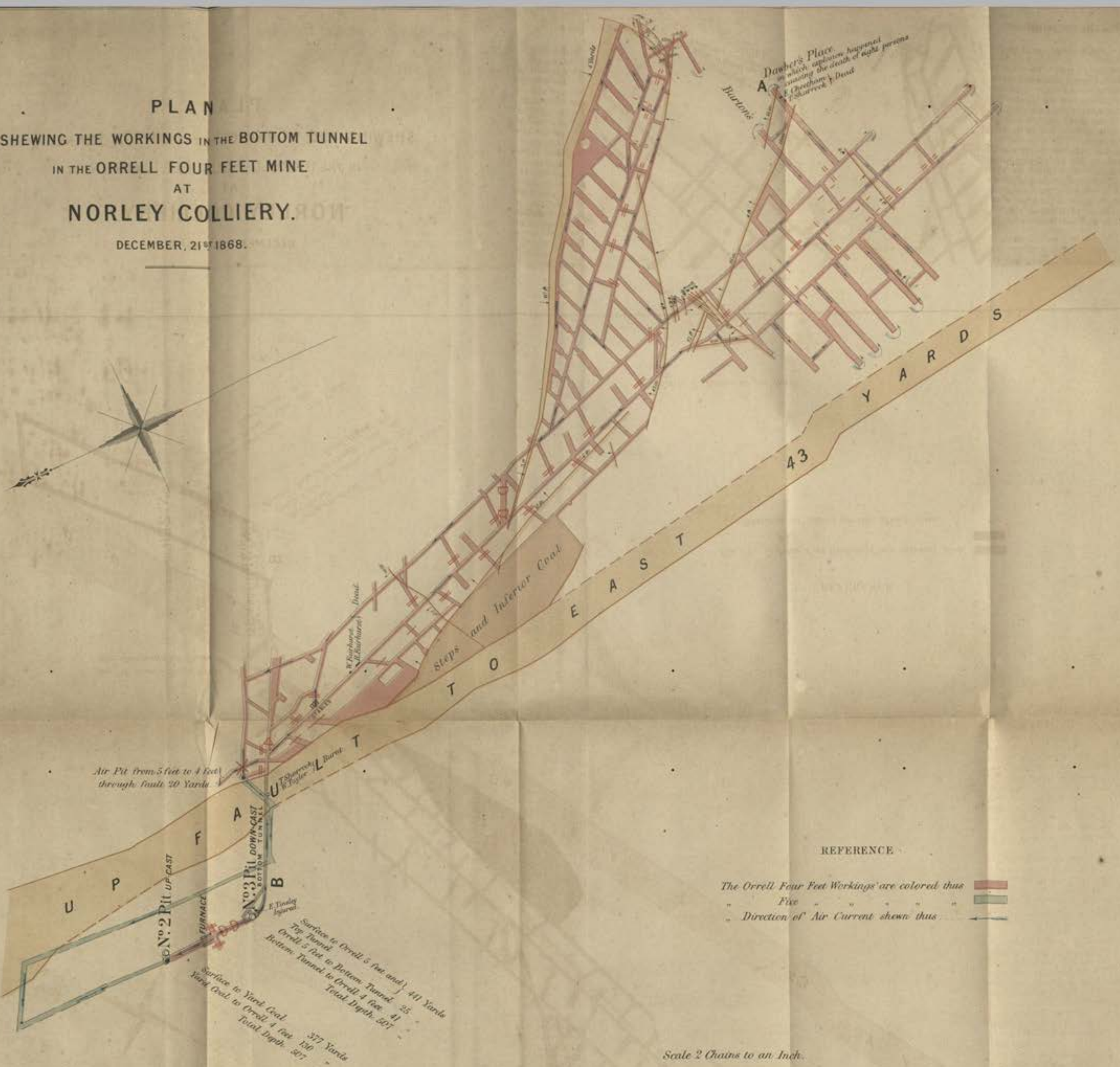
Loss of life by Suffocation, at Nut Grove Colliery, St. Helens.

The manager, the surveyor, and one of the workmen of this colliery were suffocated in foul air while attempting to extinguish a fire in one of the thick mines of this colliery, which had become ignited by the cinders from a fire-grate in the upcast pit, which had been placed there to produce ventilation. It appeared that the heat had caused the upcast pit to collapse, so that the smoke and vapour arising from the fire, together with the carbonic acid gas of the mine, filled the bottom wagon road from the downcast pit. As far as I could ascertain, they were examining the stoppings which had been put in to keep it back, and to prevent the access of air to the fire. As this mistake is often made, it is necessary that I should again explain my views on the subject. When it becomes necessary to extinguish a fire below ground, the top of the pit or the entrance to the mine at the bottom should be hermetically closed, so that no air can reach the fire. A pipe to allow the escape of gas should be fixed in the stopping in the upcast pit. If that be properly done, the fire will go out, and the heat gradually cool down in a short time. The bottom of the upcast had not been regularly examined, and the pit was only used for the egress of the return air. It was lowered and raised by a windlass on the top.

Plate 4.

PLAN
SHEWING THE WORKINGS IN THE BOTTOM TUNNEL
IN THE ORRELL FOUR FEET MINE
AT
NORLEY COLLIERY.

DECEMBER, 21st 1868.


Dawber's Place
in which explosion happened
causing the death of eight persons
A
Bartons
J. Cheetham } Dead
T. Sharrock } Dead
UP FAULT TO EAST 43 YARDS
Steps and Inferior Coal
W. Barhurst
R. Barhurst } Dead
Air Pit from 5 feet to 4 feet through fault 20 Yards
T. Sharrock
W. Taylor } Burnt
No. 2 Pit UP-CAST
FURNACE
No. 3 Pit DOWN-CAST BOTTOM TUNNEL
B
E. Tinsley Injured
Surface to Orrell 5 feet and Top Tunnel } 441 Yards
Orrell 5 feet to Bottom Tunnel 25
Bottom Tunnel to Orrell 4 feet 41
Total Depth 507
Surface to Yard Coal 377 Yards
Yard Coal to Orrell 4 feet 130
Total Depth 507

REFERENCE

The Orrell Four Feet Workings are colored thus	🟥
" Five " " " "	🟩
" Direction of Air Current shewn thus	←

Scale 2 Chains to an Inch.

Peter Higson

[illegible]

Falls of Roof.

Loss of life from falls of roof and falls of coal has been in the time under consideration far too great, but they may all be classed under two heads, of neglecting to prop and sprag, and that of pure accidents or misadventures. In the former, each individual was the sole guardian of his own safety. In the latter, further provisions seemed unnecessary, and unless men adopt greater care and thoughtfulness, such disasters will re-occur from time to time.

In Shafts.

Seventeen lives have been lost in shafts by falling into the same from the top and from mouthings part way down, by falling and being lowered into the sump, by falling out of the cage while going down and up, and by the cage falling upon them at the bottom of the pit. All these, with one exception, show an absence of ordinary care. In the exceptional case, two men descended the pit after working hours, unknown to the engine-man. The sump was uncovered for winding water, and they were lowered into it, and one of the two was drowned.

Loss of life from miscellaneous causes above and below ground.

Of the 19 persons killed below ground, and the 13 killed above ground, faint traces only in each case remained to assist me in investigating the cause thereof. No doubt, however, existed on my mind, that if the deceased persons had taken proper care of themselves those casualties would not have happened; they no sooner get accustomed to the work at one place than they leave it and go to another, so that they are continually leaving, and never acquire proficiency in their occupation. I find, as a rule, that accidents generally occur within a few days of their first beginning to work for a different employer.

It is satisfactory to find that, for the relief of the distress which these misfortunes have produced, a large sum of money has been given by the public. It would, however, be a source of comfort to the survivors of the deceased, and to those who get injured in the mines, if a permanent relief fund could be established on a good basis. Such a scheme has been seriously considered of late by some of the large employers of labour; and although it is still far from being fully matured, circumstances must ultimately render such aid to their deliberations as to bring them to a successful issue. The owners and workers of mines should co-operate, and contribute fair and reasonable proportions to the fund, out of which proper relief should be judiciously given.

As I had previously suspected the means provided for ventilating the workings in which the four great casualties of the year happened, the result shows that the boundary of inspection had been reached, that the ground beyond is extensive, and in many instances a waste and comparatively uncultivated tract, and that the time for its proper cultivation and enclosure has become an obvious necessity.

On the continent of Europe even females of tender age, and boys at the age of 10 years and upwards, are allowed to work in the mines, but competent persons only are permitted to take a part in the management of the works.

I have, &c.
(Signed) PETER HIGSON,
Inspector of Coal Mines.

The Right Hon. Henry Arthur Bruce, M.P.,
Secretary of State,
Whitehall, London.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS OF LIFE arising therefrom, in the SOUTH-WEST LANCASHIRE and NORTH WALES DISTRICT, during the Year ending 31st December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives Lost.				
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.													
Jan. 3	1	Gidlow Lane	Wigan	Rylands and Cross	Peter Wood	Collier	—	Fall of roof	–	1	–	–	–
„ 6	2	Standish	Standish, Wigan	Wigan Coal and Iron Co.	John Heas	Drawer	14	Run over by a tub below ground	–	–	–	1	–
„ 14	3	Ewloe Hall	Buckley, Mold	Ewloe Hall Coal Co.	Wm. Anglesey	Filler	—	An explosion of gas	1	–	–	–	–
„ 15	4	Wern	Bagilt, Holywell	Wern Colliery Co.	Wm. Leighton	Labourer	15	Fall of roof	–	1	–	–	–
„ 18	5	Laffak	St. Helens	Messrs. Johnson	Jos. Taylor	Engine tenter	22	Falling into the pit from surface	–	–	1	–	–
„ 20	6	Brynn Moss	Wigan	Entwistle and Whittles	Saml. Thorpe	Ditto	18	Falling into the machinery	–	–	–	1	–
„ 21	7	Moor Pit	Aspull, Wigan	Wigan Coal and Iron Co.	Wm. Unsworth	Drawer	13	Fall of roof	–	1	–	–	–
„ „	8	Ladies Lane	Hindley, Wigan	Thos. Gidlow	Jno. Walmsley	Fireman	32	Ditto	–	1	–	–	–
„ 22	9	Hindley Hall	Ditto	Pearson and Knowles	Wm. Makinson	Collier	50	Ditto	–	1	–	–	–
„ „	„	Ditto	Ditto	Ditto	Jno. Wallwork	Prop drawer	46	Ditto	–	1	–	–	–
„ 27	10	Whiston	Near Prescot	Wigan & Whiston Coal Co.	Jno. Allerton	Bricksetter	—	Falling into shaft from the surface	–	–	1	–	–
„ „	11	Coleshill	Near Flint	Wm. Jones and Co.	-	Drawer	16	Falling under his tub	–	–	–	1	–
„ 31	12	Swan Lane	Hindley Green	Edwd. Johnson	J. Butterfield	Collier	19	Falling when part way down the shaft.	–	–	1	–	–
„ „	13	Plaskynaston	Ruabon	Plaskynaston Coal Co.	Thos. Williams	Ditto	35	Fall of coal	–	1	–	–	–
Feb. 4	14	Bromfield	Mold	Bromfield Coal Co.	Saml. Edwards	Ditto	—	An explosion	1	–	–	–	–
„ 6	15	Hafod	Wrexham	Ruabon Coal Co.	Jesse Williams	Ditto	30	Falling from part way down the shaft.	–	–	1	–	–
„ 7	16	High Brooks	Wigan	Mercer and Evans	Ime Doherty	Ditto	—	An exploded shot	1	–	–	–	–
„ „	17	Crow Orchard	Ormskirk	Crow Orchard Coal Co.	Richd. Smith	Engineman	59	Falling into the machinery	–	–	–	1	–
„ 8	18	Mostyn	Holywell	Mostyn Coal Co.	Jno. Lewis	Labourer	70	Run over by a locomotive above ground.	–	–	–	–	1
„ 10	19	Plaskynaston	Ruabon	Plaskynaston Coal Co.	Richd. Fleton	Collier	26	Fall of roof	–	1	–	–	–
„ 15	20	Ladies Lane	Hindley, Wigan	Thos. Gidlow	Geo. Wilson	Ditto	37	Ditto	–	1	–	–	–
„ 18	21	Laffak	St. Helens	Messrs. Johnson	Jos. Taylor	Engineman	—	Falling into the machinery	–	–	–	1	–
„ 19	22	Springs	Ince, Wigan	Pearson and Knowles	Jno. Ashurst	Brakesman	20	Run over by a coal truck above ground.	–	–	–	–	1
„ 22	23	Wynnstay	Ruabon	New British Iron Co.	Jno. Mills	Collier	28	Fall of roof	–	1	–	–	–
„ 23	24	Lea Green	St. Helens	Jno. Middlehurst	Michl. Burn	Banksman	—	Falling into pit from surface	–	–	1	–	–
								Carried over	3	10	5	5	2

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives Lost.				
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward	3	10	5	5	2
Feb. 23	25	Ravenhead	St. Helens	Bromilow, Haydock, & Co.	Jno. Johnson	Furnaceman	58	Falling out of the cage when ascending the pit.	—	—	1	—	—
„ 28	26	Brimilow Field	Wigan	Wigan Coal and Iron Co.	Jno. Fairhurst	Collier	20	Fall of roof in the yard mine	—	1	—	—	—
Mar. 19	27	Pentre Saison	Wrexham	Pentre Saison Co.			—	Run over on an inclined plane	—	—	—	1	—
„ 20	28	Bromfield	Mold	Bromfield Coal Co.	Thos. Harris	Hooker-on	—	Falling into shaft from part way down.	—	—	1	—	—
„ „	29	Brimilow Field	Wigan	Wigan Coal and Iron Co.	Ewd. Draper	Collier	23	An explosion of gunpowder	1	—	—	—	—
„ 23	30	Englefield	Holywell	William Jones	Thos. Thomas		—	Fall of roof	—	1	—	—	—
„ 25	31	Frood	Wrexham	Sparrow and Pool	Saml. Roberts	Collier	32	Ditto	—	1	—	—	—
„ 29	32	St. Helens	St. Helens	Messrs. Pilkington	Geo. Tarr	Furnaceman	68	Found dead in the sump	—	—	1	—	—
„ 30	33	Tryddyn	Mold	Flintshire Oil Co.	Rcd. Lewis	Drawer	—	Falling out of the cage while descending the pit.	—	—	1	—	—
April 20	34	The Mesnes	Wigan	Charles Turner			—	Fall of roof	—	1	—	—	—
„ „	„	Ditto	Ditto	Ditto			—	Ditto	—	1	—	—	—
„ „	„	Ditto	Ditto	Ditto			—	Ditto	—	1	—	—	—
„ 24	35	Green Slate	Sherrington	John Redshaw and Co.	Rchd. Jolly	Collier	—	Ditto	—	1	—	—	—
May 15	36	Brimilow Field	Wigan	Wigan Coal and Iron Co.	Wm. Armstrong	Ditto	54	Ditto	—	1	—	—	—
„ 16	37	Mostyn	Holywell	Mostyn Coal Co.	Thos. Owen	Labourer	—	Ditto	—	1	—	—	—
„ 18	38	Rose Bridge	Ince, Wigan	J. G. Morriss	Thos. Anderton	Ditto	39	Fall of roof whilst drawing props	—	1	—	—	—
„ 19	39	Chapel House	Skelsmerdale	Edwd. Smith	Wm. Gaskell	Collier	—	An explosion of gunpowder	1	—	—	—	—
„ 24	40	Springs	Hindley	John Scowcroft and Co.	Thos. Ellison	Drawer	—	A blown out shot	1	—	—	—	—
„ „	„	Ditto	Ditto	Ditto	Richd. Davies	Collier	21	Ditto	1	—	—	—	—
„ 28	41	Brimilow Field	Wigan	Wigan Coal and Iron Co.	Edwd. Woodcock	Labourer	20	Run over by a locomotive above ground.	—	—	—	—	1
„ 30	42	Vron	Wrexham	Maurice and Low	Thos. Jones	Collier	62	Fall of roof	—	1	—	—	—
June 2	43	Chapel House	Ormskirk	Thos. Firrimond	Thos. Young	Ditto	—	Fall of coal	—	1	—	—	—
„ „	„	Ditto	Ditto	Ditto	Mcl. Crolly	Drawer	—	Ditto	—	1	—	—	—
								Carried over	7	23	9	6	3

List of Fatal Colliery Accidents—*continued*.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives Lost.				
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward	7	23	9	6	3
June 4	44	Black Park	Chirk	John Stott Milne and Co.	John Swain		43	An explosion of gas	1	—	—	—	—
„ „	45	Wynne Hall	Ruabon	Wynne Hall Coal Co.	Thos. Evans	Miner	—	Fall of roof	—	1	—	—	—
„ 14	46	Pemberton	Wigan	John Blundell and Sons	Thos. Tuberer	Fireman	45	Ditto	—	1	—	—	—
„ 14	47	Kirkless	Ditto	Wigan Coal and Iron Co.	Jno. Baxendale	Collier	—	A blown-out shot	1	—	—	—	—
„ 15	48	Pewfall	St. Helens	Richd. Evans and Son	Wm. Prior	Ditto	—	Fall of coal	—	1	—	—	—
„ „	49		Wigan	Wigan Coal and Iron Co.	Jas. Smith		—	Fall of roof	—	1	—	—	—
„ 26	50	Blackley Hurst	St. Helens	Samuel Stock	James Low	Banksman	63	Being caught on the arm by the descending cage.	—	—	1	—	—
July 1	51	Aston Hall	Hawarden, Mold	Aston Hall Colliery Co.	John Evans	Labourer	16	Breaking of a jig chain in the mine	—	—	—	1	—
„ 6	52	Rose Bridge	Ince, Wigan	J. G. Morris	John Rudd	Ditto	41	A railway truck supported by props falling upon him.	—	—	—	—	1
„ 7	53	Mostyn	Holywell	Mostyn Coal Co.	Thos. Jones	Collier	—	Fall of roof	—	1	—	—	—
„ 11	54	Queen's Ferry	Chester	Messrs. Thompson	Jos. Newton	Ditto	—	Fall of coal	—	1	—	—	—
„ 19	55	Rainford	St. Helens	Rainford Coal Co.	Thos. Short	Ditto	41	Ditto	—	1	—	—	—
„ 23	56	Brinks	Haigh, Wigan	Wigan Coal and Iron Co.	Chas. Collier	Ditto	20	Fall of roof	—	1	—	—	—
„ 25	57	Pemberton	Wigan	John Blundell and Son	Chas. Lane	Hooker-on	14	Struck by the descending cage at the eye of the pit.	—	—	1	—	—
„ 31	58	Moor Pit	Aspull, Wigan	Wigan Coal and Iron Co.	Chas. Gray	Labourer	—	A tub having been run against him in the mine.	—	—	—	1	—
Aug. 3	59	Vron	Wrexham	Maurice and Low	Evan Thomas	Ditto	—	Injuries received above ground	—	—	—	—	1
„ 5	60	Parr	St. Helens	Richd. Evans and Sons	Jas. Potter	Drawer	17	Drowned in the sump	—	—	—	1	—
„ 9	61	Little Mountain	Buckley, Mold	Little Mountain Colliery Co.	Jno. Rowland	Collier	—	Fall of roof	—	1	—	—	—
„ 10	62	Norley	Wigan	Norley Colliery Co.	Jno. Edwards	Ditto	—	Fall of coal	—	1	—	—	—
„ „	63	Pemberton	Ditto	Jno. Blundell and Sons	Wm. Cadman	Wagoner	—	Being run over by coal truck above ground.	—	—	—	—	1
„ 12	64	Bronwhlfa	Mold	Whilfa Colliery Co.	Robt. Roberts	Collier	—	Fall of roof	—	1	—	—	—
„ „	65	Peasley Cross	St. Helens	Bournes and Co.	Rhd. Cottam	Ditto	36	Struck by a tub on an inclined plane	—	—	—	1	—
„ 17	66	Brynn Moss	Wigan	Entwistle and Whittles	Rchd. Johnson	Engineman	56	Falling into the machinery	—	—	—	1	—
„ „	67	Swan Lane	Ditto	Edward Johnson	Chas. Abbott	Jigger	35	An explosion	1	—	—	—	—
								Carried over	10	34	11	11	6

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives Lost.				
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward	10	34	11	11	6
Aug. 17	67	Swan Lane	Wigan	Edward Johnson	John Reeves	Collier	30	An explosion	1	—	—	—	—
" "	"	Ditto	Ditto	Ditto	Jos. Phinee	Fireman	35	Ditto	1	—	—	—	—
" 20	68	Pewfall	St. Helens	Richard Evans and Sons	Jos. Travis	Collier	35	Fall of roof	—	1	—	—	—
" 14	69	Rose Bridge	Wigan	J. G. Morris	Jas McMain	Ditto	22	Ditto	—	1	—	—	—
Sept. 1	70	Plaskynaston	Ruabon	Plaskynaston Coal Co.	Wm. Thomas	Ditto	26	Ditto	—	1	—	—	—
" "	71	Bymbo	Wrexham	The Brymbo Colliery Co.	Thos. Reynolds	Drawer	12	Struck by the descending cage in the eye of the pit.	—	—	—	1	—
" 4	72	Kirkless Hall	Wigan	Wigan Coal and Iron Co.	Jno. Hughes	Collier	22	Fall of roof	—	1	—	—	—
" 7	73	Ruabon	Ruabon	Ruabon Coal and Coke Co.	Jno. Evans	Sinker	—	An explosion in a sinking pit	1	—	—	—	—
" 8	74	Moor Pit	Aspull, Wigan	Wigan Coal and Iron Co.	Rd. Lathom	Collier	—	Fall of roof	—	1	—	—	—
" 10	75	Flint Marsh	Flint	Jno. Ormeston and Co.	Robt. Jones	Ditto	—	Ditto	—	1	—	—	—
" 12	76	Springs	Wigan	Pearson and Knowles	H. McDonald	Ditto	32	Ditto	—	1	—	—	—
" 15	77	Black Park	Chirk	Jno. Stott Milne and Co.	Robt. Owen	Ditto	36	Ditto	—	1	—	—	—
" 16	78	Mostyn	Holywell	Mostyn Coal Co.	Jos. Richards	Ditto	19	Fall of coal	—	1	—	—	—
" 17	79	California	Aspull, Wigan	Wigan Coal and Iron Co.	Jno. Ainscough	Ditto	39	Fall of roof	—	1	—	—	—
" 18	80	Fir Tree House	Ince, Wigan	Crompton and Shawcross	- -	- -	—	Run over by a tub below grouud	—	—	—	1	—
" 24	81	Pewfall	St. Helens	Richd. Evans and Sons	Thos. McDonald	Labourer	—	Ditto ditto	—	—	—	1	—
" 26	82	Ince Springs	Wigan	Pearson and Knowles	Thos. Clayton	Collier	—	Fall of roof	—	1	—	—	—
" 30	83	Vron	Wrexham	Maurice and Low	D. Humphries	Ditto	44	Falling out of cage while ascending the pit.	—	—	1	—	—
" "	84	Wynnstay	Ruabon	New British Iron Co.	- -	- -	—	An explosion; 10 persons killed, and 13 injured.	10	—	—	—	—
Oct. 5	85	Ince Hall	Ince, Wigan	Ince Hall Coal and Cannel Co.	Jno. Dermont	Collier	16	Fall of roof in the Cannel mine	—	1	—	—	—
" 6	86	Cae Pen-ty	Frood, Wrexham	Thos. Roberts and Co.	Abbr. Gabbott	Drawer	41	Fall of coal from the sides of main coal.	—	1	—	—	—
" 9	87	Ladies Lane	Hindley, Wigan	Thos. Gidlow	Jos. Parkinson	Collier	45	Fall of coal in the Arley mine	—	1	—	—	—
" 10	88	Lindsay Pit	Haigh	Wigan Coal and Iron Co.	Thos. Forshaw	Door tenter	13	Crushed by boxes in the Arley mine	—	—	—	1	—
								Carried over	23	48	12	15	6

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives Lost.				
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward	23	48	12	15	6
Oct. 12	89	Frood	Wrexham	Sparrow and Poole	Wm. Roberts	Drawer	—	An explosion of firedamp (yard coal)	1	–	–	–	–
„ 14	90	Ditto	Ditto	Ditto	Jno. Grey	Ditto	—	Fall of roof in the main coal	–	1	–	–	–
„ 15	91	Edge Green	Golborne	Richd. Evans and Sons	W. Twiss	Daitler	21	Fall of roof in the Wigan 4-ft. mine	–	1	–	–	–
„ 16	92	Upholland	Wigan	Dillon Brook Coal Co.	Thos. Rigby	Sinker	52	A drill falling upon him out of the tub while it was being lowered from the top.	–	–	1	–	–
„ „	93	Westminster	Wrexham	Westminster Coal Co.	Wm. Edwards	Chartermaster	39	Fall of roof in the main coal mine	–	1	–	–	–
„ 20	94	Parr	St. Helens	Richd. Evans and Sons	Jno. Chorley	Collier	44	Falling out of cage while ascending	–	–	1	–	–
„ 21	95	Rose Bridge	Ince, Wigan	J. G. Morris	Wm. Rowson	Ditto	54	Fall of roof in the Cannel mine	–	1	–	–	–
„ 23	96	Pentre Saisons	Minera, Wrexham	Pentre Saison Coal Co.	Jno. Owens	Ditto	—	Fall of roof	–	1	–	–	–
„ 24	97	Vron	Wrexham	Maurice and Low	Jno. Rogers	Drawer	15	Falling into shaft from a mouthing	–	–	1	–	–
„ 26	98	Waterloo	Ruabon	Plaskynaston Coal Co.	Saml. Lloyd	Stranger	10	Caught in a revolving chain	–	–	–	–	1
„ 29	99	Kirkless	Wigan	Wigan Coal and Iron Co.	Frank Murphy	Labourer	65	Run over by a locomotive above ground.	–	–	–	–	1
„ 31	100	Waterloo	Ruabon	Plaskynas Coal Co.	Jno. Turner	Collier	42	Fall of roof	–	1	–	–	–
Nov. 2	101	California	Aspull, Wigan	Wigan Coal and Iron Co.	Hugh Hayes	Labourer	65	Run over by coal trucks on branch railway.	–	–	–	–	1
„ „	102	Nut Grove	St. Helens	James Radley	Wm. Naylor	Underlooker	54	Suffocation in noxious vapour produced by the mine being on fire	1	–	–	–	–
„ „	„	Ditto	Ditto	Ditto	Jno. Campbell	Surveyor	21		1	–	–	–	–
„ „	„	Ditto	Ditto	Ditto	Wm. Foster	Wagoner	42		1	–	–	–	–
„ 4	103	Upholland	Wigan	Wigan Coal and Iron Co.	Jno. Pennington	Jigger	14	Deceased was in front of a full tub on the top of a self-acting plane when the chain broke.	–	–	–	1	–
„ 5	104	Ince Hall	Ditto	Ince Hall Coal and Cannel Co.	Peter Conway	Drawer	25	Crushed by a tub, and seriously injured.	–	–	–	1	–
„ 11	105	Hanmer	Mostyn, Holywell	Eyton and Elliot	Joshua Price	Collier	28	Fall of coal	–	1	–	–	–
„ „	„	Low Hall	Wigan	Moss Hall Coal Co.	-	-	—	Run over by railway truck on surface.	–	–	–	–	–
„ 18	106	Bronwhlfa	Mold	Bromwhylfa Coal Co.	Geo. Mathews	-	—	Fall of roof	–	1	–	–	–
								Carried over	27	56	15	17	9

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives Lost.				
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward -	27	56	15	17	9
Nov. 18	107	Low Hall -	Wigan -	Moss Hall Coal Co. -	M. Gerrar -	Wagoner -	12	Fell off buffer and was run over above ground.	—	—	—	—	1
„ 25	108	Little Mountain	Buckley, Mold -	Little Mountain Coal Co.	Ste. Ashton -	Collier -	40	Fall of coal - - - - -	—	1	—	—	—
„ 24	109	Black Park -	Chirk - -	John Stott Milne and Co.	Jos. Hunter -	Underlooker	28	Run over by a train of tubs at the foot of an engine plane.	—	—	—	1	—
„ 25	110	Hindley Green	Hindley, Wigan	John Scowcroft and Co. -	- - -	- - - -	—	An explosion of fire-damp - -	62	º	—	—	—
„ 28	111	Crank - -	Rainford - -	Crank Coal Co. - -	Jas. Roughley -	Banksman -	46	Lowered into the sump - -	—	—	1	—	—
Dec. 1	112	Swan Lane -	Hindley, Wigan -	Edward Johnson -	Wm. Davenport -	Collier -	45	Fall of roof - - - - -	—	1	—	—	—
„ 9	113	Ince Hall -	Ince, Wigan -	Ince Hall Coal, &c. Co -	A. O'Connell -	Ditto -	21	Ditto - - - - -	—	1	—	—	—
„ 10	114	Ladies Lane -	Hindley, Wigan -	Thos. Gidlow - -	Geo. Pendlebury -	Banksman -	45	Falling into pit from surface -	—	—	1	—	—
„ 9	115	Wynn Hall -	Ruabon -	Wynn Hall Coal Co. -	Robt. Roberts -	Collier -	—	An explosion of fire-damp - -	1	—	—	—	—
„ 12	116	Haydock -	St. Helens -	Richd. Evans & Sons	J. Leatherbarrow -	Ditto -	27	Fall of roof - - - -	—	1	—	—	—
„ 13	117	California -	Aspull, Wigan -	Wigan Coal and Iron Co. -	Jas. Leigh -	Ditto -	43	Ditto - - - - -	—	1	—	—	—
„ 17	118	Springs -	Ince, Wigan -	Pearson and Knowles -	Thos. Caran -	Hooker-on	—	Struck by descending cage -	—	—	1	—	—
„ 18	119	Vron - -	Wrexham -	Maurice and Low -	Jno. Williams -	Wagoner -	—	Run over by a loaded wagon below ground.	—	—	—	1	—
„ 19	120	Flint Marsh -	Flint - -	Jno. Ormiston and Co. -	Robt. Ellis -	Collier -	—	An explosion - - - - -	1	—	—	—	—
„ 21	121	Lindsay Pit -	Haigh, Wigan -	Wigan Coal and Iron Co.	Patk. Regan -	Ditto -	22	Fall of roof - - - - -	—	1	—	—	—
„ „	122	Norley -	Wigan - -	The Norley Colliery Co. -	- - -	- - - -	—	An explosion of fire-damp - -	8	—	—	—	—
„ 22	123	Brynn Hall -	Ditto -	W. and J. Crippin -	Jas. Cummin -	Labourer -	26	Crushed between railway trucks -	—	—	—	—	1
„ „	124	Aspull -	Ditto -	Wigan Coal and Iron Co.	Hy. Hackett -	Coke burner	—	Run over by a locomotive above ground.	—	—	—	—	1
„ „	125	Blackleyhurst -	St. Helens -	Saml. Stock - -	Lydia Roby -	Labourer -	17	Coal cleaner - - - -	—	—	—	—	1
„ 26	126	Haydock -	Ditto -	Richd. Evans and Sons -	- - -	- - - -	—	An explosion - - - -	26	—	—	—	—
								Total -	125	62	18	19	13

SUMMARY of the FATAL COLLIERY ACCIDENTS, and LOSS of LIFE arising therefrom, in the SOUTH-WEST LANCASHIRE and NORTH WALES DISTRICT, during the Year ending 31st December 1868.

No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Number of Lives lost.					
				Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
20	Haigh, Aspull, Kirkless, Holland, and Standish.	Wigan	Wigan Coal and Iron Co.	2	10	–	4	4	20
1	Ewloe Hall	Buckley	Ewloe Hall Co.	1	–	–	–	–	1
1	Wern	Bagilt	Wern Colliery	–	1	–	–	–	1
2	Brynn Moss	Wigan	Entwistle and Whittles	–	–	–	2	–	2
2	Laffax Lane	Ditto	Messrs. Johnson	–	–	1	1	–	2
4	Ladies Lane	Ditto	Thos. Gidlow	–	3	1	–	–	4
5	Hindley Hall, Springs and Moss.	Ditto	Pearson and Knowles	–	4	1	–	1	6
1	Whiston	Prescott	Wigan and Whiston Co.	–	–	1	–	–	1
2	Englefield	Holywell	Wm. Jones and Co.	–	1	–	1	–	2
3	Swan Lane	Wigan	E. Johnson	3	1	1	–	–	5
5	Plaskynaston	Ruabon	Plaskynaston Coal Co.	–	4	–	–	1	5
2	Bromfield	Mold	Bromfield Coal Co.	1	–	1	–	–	2
2	Ruabon	Ruabon	Ruabon Coal Co.	1	–	1	–	–	2
1	Park Lane	Wigan	Mercer and Evans	1	–	–	–	–	1
1	Crow Orchard	Ormskirk	Crow Orchard Coal Co.	–	–	–	1	–	1
4	Mostyn	Holywell	Mostyn Coal Co.	–	3	–	–	1	4
2	Wynnstay	Ruabon	New British Iron Co.	10	1	–	–	–	11
1	Sutton	St. Helen's	Jno. Middlehurst	–	–	1	–	–	1
1	Ravenhead	Ditto	Bromilow, Haydock, & Co.	–	–	1	–	–	1
2	Pentresaison	Wrexham	Pentresaison Co.	–	1	–	1	–	2
3	Frood	Ditto	Sparrow and Pool	1	2	–	–	–	3
1	St. Helen's	St. Helen's	Messrs. Pilkington	–	–	1	–	–	1
1	Leeswood Hill	Mold	Flintshire Oil Co.	–	–	1	–	–	1
1	The Mesnes	Wigan	Chas. Turner	–	3	–	–	–	3
1	Green Slate	Ditto	Jno. Redshaw and Co.	–	1	–	–	–	1
4	Douglas Bank	Ditto	J. G. Morris	–	3	–	–	1	4
1	Chapel House	Ormskirk	Ed. Smith	1	–	–	–	–	1
2	Hindley Green	Wigan	Jno. Scowcroft and Co.	64	–	–	–	–	64
5	Vron	Wrexham	Morris and Low	–	1	2	1	1	5
1	Chapel House	Ormskirk	Thos. Farrimond	–	2	–	–	–	2
3	Black Park	Chirk	J. S. Milne and Co.	1	1	–	1	–	3
2	Wynn Hall	Ruabon	Wynn Hall Coal Co.	1	1	–	–	–	2
3	Pemberton	Wigan	Jno. Blundell and Son	–	1	1	–	1	3
8	Haydock and Edge Green.	St. Helen's	Richd. Evans and Sons	26	4	1	2	–	33
1	Aston Hall	Hawarden	Aston Hall Colliery Co.	–	–	–	1	–	1
2	Blackley Hurst	St. Helen's	Saml. Stock	–	–	1	–	1	2
1	- - -	- -	Messrs. Thompson	–	1	–	–	–	1
1	Rainford	St. Helen's	Rainford Coal Co.	–	1	–	–	–	1
2	Little Mountain	Buckley	Little Mountain Coal Co.	–	2	–	–	–	2
2	Norley	Wigan	Norley Colliery Co.	8	1	–	–	–	9
1	Bronwhilfa	Mold	Whilfa Colliery Co.	–	1	–	–	–	1
1	Peasley Cross	St. Helen's	Bournes and Co.	–	–	–	1	–	1
1	Brymbo	Wrexham	Brymbo Colliery Co.	–	–	–	1	–	1
2	Flint Marsh	Flint	Jno. Ormeston and Co.	1	1	–	–	–	2
1	Old Ince Hall	Wigan	Crompton and Shawcross	–	–	–	1	–	1
3	Ince Hall	Ditto	Ince Hall Coal Co.	–	2	–	1	–	3
1	- - -	- -	Thos. Roberts and Co.	–	1	–	–	–	1
1	Upholland	Wigan	Dillon Brook Coal Co.	–	–	1	–	–	1
1	Westminster	Wrexham	Westminster Coal Co.	–	1	–	–	–	1
1	Nut Grove	St. Helen's	Jas. Radley	3	–	–	–	–	3
1	Hanmer	Holywell	Eyton and Elliott	–	1	–	–	–	1
1	Moss Hall	Wigan	Moss Hall Coal Co.	–	–	–	–	1	1
1	Bromwhilfa	Mold	Bromwhilfa Coal Co.	–	1	–	–	–	1
1	Crank	St. Helen's	Crank Colliery Co.	–	–	1	–	–	1
1	Brynn Hall	Wigan	W. and J. Crippin	–	–	–	–	1	1
1	Gidlow Lane	Ditto	Rylands and Cross	–	1	–	–	–	1
126			Total	125	62	18	19	13	237

Mr. Evans' Report.

REPORT on the INSPECTION of COAL MINES, and the MINES of IRONSTONE of the COAL MEASURES worked in connexion with COAL, &c., in the MIDLAND DISTRICT, for the Year ended 31st December 1868.—By THOMAS EVANS, Esq., F.G.S.

SIR, Field Head House, Belper, 1st March 1869.

I have the honour to transmit for your consideration this my Thirteenth Annual Report on the working of the several Acts of Parliament for the regulation and inspection of mines; and for the fourth time on the Midland District, comprising the counties of Derby, Nottingham, Leicester, and Warwickshire.

It is satisfactory to be able to report that although there is a small increase in the total quantity of coal raised, the number of lives lost from accidents in or about the collieries of the district is less than the preceding year. The quantity of coal worked in the year 1867 was (7,600,000) seven million six hundred thousand tons, lives lost (64) sixty-four, or one death to every (118,750) one hundred and eighteen thousand seven hundred and fifty tons; whereas in the year 1868, coal worked (7,699,000) seven million six hundred and ninety-nine thousand tons, lives lost (60) sixty, or one death to (128,317) one hundred and twenty-eight thousand three hundred and seventeen tons.

It will be seen on reference to the General Statistics accompanying the Reports of the Inspectors of Mines, that in Great Britain the quantity of coal worked in the past year (1868) is one hundred and four millions six hundred thousand tons, the total deaths one thousand and eleven, or one life lost to every one hundred and three thousand four hundred and sixty tons.

The Midland District compares most favourably with the rest of Great Britain.

Five separate accidents have been reported this year as having happened in the ironstone mines of the coal measures, attended with the loss of five lives. I again repeat that I do not place full confidence in this return, for it is difficult, indeed almost impossible, to determine what constitutes an ironstone mine worked in connexion with coal, or with any disused or exhausted coal mine. It is contended by some that coal worked with the ironstone must be of commercial value, whereas by others it is thought any coal, irrespective of its value, (thickness, quality, &c.,) if worked together with the ironstone, comes within the meaning and provisions of the Act of Parliament (23 & 24 Vict., cap. 151.) Now it appears to me that persons employed underground in the mines of ironstone are liable to precisely similar accidents in character to coal miners, and as the law was made and is intended for the protection and safety of the workmen, it would in my opinion be most desirable in any future legislation on the subject to include all ironstone mines worked underground in the law for the inspection and regulation of mines.

TABLE No. 1.

TABLE showing the Number of Deaths, the Coal raised, and the Number of Tons of Coal raised for each Death during the 13 years ended 31st December 1868.

Dates.	Explosions of Gas.	Inundation of Water.	Falls of Coal.	In Shafts.	Crushed by Tubs, and Miscellaneous Accidents.	Total.	Tons of Coal raised.	Tons of Coal raised for each Death.
1856	3	—	21	16	6	45	4,500,000	97,000
1857	15	—	14	6	20	55	4,750,000	86,000
1858	—	—	16	16	10	42	5,060,000	121.000
1859	2	—	18	13	7	40	5,460,000	134,000
1860	3	—	21	13	13	50	6,215,000	124,000
1861	3	23	21	15	7	69	6,503,319	94,000
1862	2	—	25	4	12	43	6,647,000	154,000
1863	4	5	26	9	8	52	7,000,000	134,000
1864	11	—	30	9	16	66	7,300,000	110,000
1865	9	—	36	13	24	82	7,575,000	92,383
1866	7	—	26	6	19	58	7,600,000	131,034
1867	4	—	25	11	19	64	7,600,000	118,750
1868	1	—	24	9	26	60	7,699,000	128,317

TABLE No. 2.

SUMMARY of separate Colliery Accidents in the Midland District during the years 1867 and 1868.

	1867.	1868.
Explosions of fire-damp	2	1
Falls of roof	25	24
Shaft	11	9
Miscellaneous	21	24
Total accidents	59	58

SUMMARY OF LIVES LOST IN THE ACCIDENTS.

	1867.	1868.
Explosions of fire-damp	4	1
Falls of roof	25	24
Shafts	11	9
Miscellaneous	24	26
Total deaths	64	60

Shaft Accidents.

	1867.	1868.
Falling from part way down	1	5
Things falling from surface	2	—
„ „ „ part way down	1	1
Ropes and chains breaking	—	1
Whilst ascending and descending	5	1
Explosion of powder	—	1
Overwinding	1	—
Suffocated in sinking shaft	1	—
Total	11	9

Miscellaneous.

	1867.	1868.
Explosions of gunpowder	5	8
Suffocation by gases	1	2
On incline planes	2	7
By trams and tubs	12	5
Boilers bursting	3	—
On surface, machinery	1	1
„ „ run over	—	3
Total	24	26

TABLE No. 3.

SHOWING the Number of Male Coal Miners employed in and about the Coal Mines of the Midland District, Lives lost, and Tons of Coal raised per Life lost.

—	Persons employed.	Deaths.	Coal raised.	Tons of Coal raised per Life lost.
Derbyshire	16,240	33	4,957,879	150,239
Nottingham	5,719	11	1,508,439	137,131
Leicester	3,019	8	608,088	76,011
Warwick	3,022	8	624,859	78,107
Total	28,000	60	7,699,265	128,321

The death rate in proportion to the persons employed, and the coal raised, is much greater in the smaller coal districts of Leicester, and Warwick, than in those of the Counties of Derby, and Nottinghamshire. In Leicestershire the mines are of great thickness, and in many cases the roofs are dangerous, requiring great attention and care.

In Warwickshire the mines are also thick, the inclination towards the west is from 15 to 20 inches in the yard, with often a tender roof.

Large quantities of Clay Ironstone are worked in Warwickshire and taken into South Staffordshire to be smelted; there being no blast furnaces in the county, the coal is not suitable for iron-making purposes.

TABLE No. 4.

LIST of COLLIERIES where Accidents have taken place in the years 1865, 1866, 1867, and 1868.

Name of Colliery.	Owner's Name.	Total Deaths in 4 years.
Clay Cross	William Jackson & Co.	31
Butterley Coal and Iron Company	Wright & Jessop	28
Staveley	Staveley Coal and Iron Company, Limited	25
Cinder Hill, Newcastle and Babington	Executors of Thomas North	11
High Park, Watnall, Eastwood, Cotmanhay, Hill Top, Langly, &c.	Barber, Walker & Co.	11
Swannington, Coleorton, &c.	Walker and Worswick	10
Bretby	The Earl of Chesterfield	7
Swadlincote, Cadley Hill	Hall and Boardman	6
Snibston	G. Stevenson & Co.	6
Stanton	Nadin & Co.	6
Nesfield, Sheepbridge, &c.	Sheepbridge Iron Company, Limited	6
Hawkesbury	J. Darlington & Co.	6
Victoria	— Troughton	5
Birley Vale	Jeffcock and Dunn	5
Moira, Church Gresley, Oakthorpe	Executors of Marquis of Hastings	5
Glascote	Firmstone & Co.	4
Riddings, Selston, &c.	James Oakes & Co.	4
Shirland	H. Baillie	4
Gresley Wood	Gresley Wood Company, Limited	4
Shipley	A. M. Mundy	4
Swanwick	Moorewood	4
Renishaw Park, &c.	J. and G. Wells	4
Oakerthorpe, Highfield, &c.	Oakerthorpe Iron Company, Limited	3
Nailstone	J. Ellis	3
Kettlebrooke	Executors of Dumulo	3
Wingerworth	Wingerworth Coal Company	3
Denby	G. and W. H. Dawes	2
Shireoaks	Shireoaks Colliery Company, Limited	2
Unston	Rangeley	2
Pinxton	Coke & Co.	2
Haunch Wood	Nowell & Son	2
Whitwick	Executors of J. Whetston	2
Ibstock		2
Denby	W. D. Lowe	2
Hucknall Torkard	E. Ellis & Co.	2
Birchwood	C. Seeley & Co.	2
Digby	Hall & Co.	2
Tibshelf	J. Chambers	2
Tame Valley	Nock Brothers	1
Bridgehouse	J. Sayer	1
Kilburne	J. Rae	1
Stoneyford	J. Wooley	1
Danesmoore	Smith and Shepherd	1
Charity	Addenbrook and Pidcock	1
Grassmoore	Barnes	1
Pooley Hall	Limited Liability Company	1
Bagworth	Executors of Viscount Maynard	1
Boythorpe	Wingerworth Coal Company	1
Baddesley	W. S. Dugdale	1
Giltbrook	Hicks and Whittaker and Co.	1
Devonshire	Devonshire Silkstone Company	1
Rutland	Executors of Potter	1
West Hallam	F. Newdegate	1
Renishaw	Appleby	1
Hill Top	C. Booth	1

Name of Colliery.	Owner's Name.	Total Deaths in 4 years.
Brampton	Limited Company	1
Molyneux	Eastwood and Swingler	1
Tapton	Tapton Coal Company, Limited	1
Polesworth	Harris and Shaw	1
Sutton	Executors of Richard Arkwright	1
West Staveley	William Bainbridge & Co.	1
Annesley	William Worswick	1
Tapton	Tapton Company	1
Blackwall	E. Chambers	1
Granville	Executors of Court Grenville	1
Wilnecote	Perrins and Harris	1
Nuneaton New Colliery	Limited Company	1
Newbold	C. H. Plevins	1
Alma	Limited Company	1
Skegby	Skegby Coal Company	1
	Total	264

Lives lost in 4 years.	Coal raised.	Coal raised for each Death.
264	30,474,000	115,053

Explosions of gas.

Only one fatal accident from "explosion of gas" has taken place during the year, one life was lost thereby; and this with ordinary care might have been prevented.

It occurred on the eighteenth of May at the Cinderhill Colliery, belonging to the trustees of the late Thomas North, it is one of the most extensive in the county of Nottinghamshire.

I made an examination of the workings soon after the explosion. It appeared a little gas lodged in the roof of the mine in consequence of a partial stoppage of the air. The deputy knew of the presence of gas in this place, and had given directions to open out the air-way, and thus restore the ventilation; he had however neglected to see, *himself*, that the persons employed at this work were supplied with safety lamps "properly locked, and examined," but allowed the deceased to have a naked light within a few yards of the gas; and at this exposed light the explosion took place, and killed a collier named William Hardy. I have had reason on previous occasions to complain of the general management, ventilation, and supervision of this colliery; it is only fair, however, to state the present owners, and agents, are doing all in their power to make matters safe, and I doubt not that Cinderhill, and the other collieries, belonging to these gentlemen will be again in as good a condition as they used to be in years gone by.

Falls of roof.

The average "loss of life" from "falls of roof" and "sides of working places," for the past ten years, is twenty-five, or one in excess of the present year. I still think, indeed I know, that some of these are preventable, not without watchfulness, and care, on the part of the colliers, strict supervision on the part of those in authority, and punishment for disobedience to the special rules, which have been framed and made law solely for the protection and security of the collier himself.

I seldom go into a colliery without having to point out places left insufficiently supported, especially in "holeing" under the coal, even although the law distinctly directs that short "sprags" or props, must be set every two yards, before the "holers" commence to undermine the coal. It will be readily seen that much depends on the man himself, whether his place is safe, or unsafe, and if he will persist in the careless neglect of such important duties as I have described, accidents, and deaths will certainly go on increasing.

It is worthy of remark, and deserves the earnest attention and consideration of all engaged in the management of mines, that in Great Britain the loss of life

From Falls of Coal in 1868, is 445, Explosions of Gas, 154.
„ „ 1867 „ 449, „ „ 286.

The horrors attending an explosion of gas are soon heard of far and near, they awaken public sympathy, and the awfully sudden loss of so many lives is immediately brought before their notice, when handsome sums of money are given for the bodily relief of the widows, and children.

Deaths from falls of roof amount in the aggregate to nearly double the number by explosions, they occur singly, the public know nothing of them; the individual privation and suffering is often keenly felt by those who are left without their protector, nearly always their only support.

I must, however, not omit to state that at some of the large works benefit clubs have been established for the relief of the sick, or injured, and some assistance in case of death from accident. The owners give an annual subscription, and the men pay weekly a fixed sum, and the management is left to a Committee elected by the men; these societies have been found to work well, and do good service in times of need.

Deaths from Falls of Roof have taken place at the under-mentioned Collieries during the years 1867 and 1868.

Name of Colliery.	Owner's Name.	Deaths.	
		1867.	1868.
Butterley	Butterley Iron and Coal Company	6	1
Staveley	Staveley Coal and Iron Company	3	3
Clay Cross	William Jackson & Co.	3	3
High Park, Eastwood, &c.	Barber, Walker, & Co.	—	3
Sheepbridge, &c.	Sheepbridge Company, Limited	—	3
Swannington, &c.	Walker and Worswick	—	3
Stanhope	E. Nadin & Co.	2	—
Nailstone	J. Ellis & Co.	2	—
Cinderhill, &c.	Exors. of Thomas North	2	—
Glascote	Firmstone	1	—
Molyneux	Eastwood and Swingler	1	—
Pinxton	Coke & Co.	1	—
Haunch Wood	Nowell & Son	1	—
Shirland	H. Baillie	1	—
Swadlincote	Hall and Boardman	1	—
Hill Top	C. Booth	1	—
Hucknall Torkard	E. Ellis & Co.	—	1
Whitwick	Exors. of Whetstone	—	1
Victoria	Troughton	—	1
Charity	Addenbrooke and Pidcock	—	1
Oakthorpe	Marquis of Hastings' Exors.	—	1
Newbold	C. H. Plevins	—	1
Shireoakes	Shireoakes Colliery Company	—	1
Granville	Exors. of Cornt Grenville	—	1
	Total	25	24

—	Deaths from "Falls."	Coal raised.	Tons of Coal raised for each Death by Falls of Roof.
1867	25	7,600,000	304,000
1868	24	7,699,000	320,708

Shafts.

Nine deaths from shaft accidents, this is two less than the preceding year; five persons were killed by falling part way down, one, whilst ascending, one, a stone falling from the side, one, through defective machinery, and recklessness on the part of deceased, and others, and one, from the effects of an explosion of powder.

Some of these were purely accidental, others however it cannot be denied with care might not have happened.

No. 3 in the schedule of accidents.

Joan Murpher, a sinker, was employed with others at the High Park Colliery, belonging to Messrs. Barber, Walker, & Co.; on the night of the 4th of January they were engaged in wedging the cast-iron tubbing in the upcast shaft, and to enable them to do this, a temporary scaffold was suspended for them to stand on.

It appeared from the evidence given at the inquest that for the purposes of the ventilation of the mine a large square hole was made in the centre of the platform. The men were lowered in a bucket, on to the platform, and deceased not knowing of this hole, stepped out, and fell to the bottom of the pit, and was instantly killed; the master sinker knew deceased was an inexperienced man, yet he allowed him to descend without taking the precaution of warning him of the danger, or even giving him a light. I considered, and pointed out to the jury, the conduct of the man in charge of this work was most careless and reprehensible, he ought to have gone down, himself, first, and remained down whilst the men were at work, or until, he was relieved by another responsible person; the jury first, then, returned a verdict of manslaughter against the master sinker, but on further consideration of the same evidence, thought differently, and returned another verdict, that of accidental death.

The manager of the colliery did not further employ this master sinker.

No. 8 *accident.*

Benjamin Knight fell out of the cage in "coming up" an upcast shaft belonging to the Hawkesbury Colliery Company.

On examination I found the machinery generally in good working order, but the discharge of steam, and heat from the underground engine boilers, made the shaft very hot, unusually so. The practice which prevails in some of the collieries in the Midland district, of lowering, and raising persons, through hot and unhealthy upcast shafts, is most objectionable. In this case he was supposed to have fallen accidentally out of the cage.

No. 28 *accident.*

Deceased met his death in passing under the shaft at Seymour Colliery, contrary to the rules; there is no necessity for passing under this shaft at any time, as there are proper roads around the pit bottom.

No. 29 *accident.*

John Holmes, a collier, was killed, and two other men were seriously injured in a shaft, at a small colliery, near the town of Clay Cross, belonging to Messrs. Smith, and Shepherd. A pair of shallow pits had recently been sunk to work a few acres of outcrop coal, and ironstone. Deceased and the two injured men, on the morning of the 7th July, in attempting to descend into the mine, jumped into a tub (which was used for the purpose of lowering, and raising persons, and material), and instantly all were precipitated to the bottom.

On examination I found the shaft was not fitted with guides, and the tub worked loose; it was fastened to the rope by means of a "ring and hook," and, to prevent it from unhooking itself, was tied with a piece of hemp yarn; when the tub was last at the bottom, the slack rope hung over its side and drew the hook out of the ring, fastening itself to the yarn, and was thus brought to the surface; the fastenings, or rope were not examined, and directly the men got on the tub the yarn gave way.

The colliery was not at work that day, and these men had no right to attempt to descend, as the bankman was away, and in fact there was no responsible man in charge of the place.

No. 52 *accident.*

Suffocation by gases.

Two men lost their lives at the Gresley Wood Colliery, on the 4th of November, through inhaling noxious gases.

The main coal of this district (Leicestershire) for the most part is liable to ignite spontaneously, and unless carefully watched is most dangerous.

In this case it appears the night fireman (or deputy underlooker) on the night of the 4th of November, went his usual rounds and returned to the bottom of the shaft; he was very much exhausted, and seeing the ostler he requested him to stop any person from going into No. 4 stall, as "there was a good deal of gas there." A few hours after this conversation the two men belonging to No. 4 stall, came down the shaft (one of them being the son of the ostler); they were told not to go to their work, it was not safe, and that the fireman was then in an unconscious state, lying near the furnace; this however, did not satisfy them, for they all three, (the father, his son, and another,) went into No. 4 stall, and on getting there one said "it is too strong for me, I shall go," and then they all left. In the morning the two men were missed, search was made, and their dead bodies found near the entrance to this stall; they had gone back a second time, after parting with the ostler, the coal was found to be on fire, and of course giving off the results of combustion, together with the decomposition of pyrites; death must have been instantaneous.

These poor fellows contributed, no doubt, to their own death, and there was therefore no criminal blame to attach to any one.

The colliery was in a very bad state, and quite unfit for persons to work in. The ventilation was defective, and through carelessness fires were constantly going on. I should state the present manager, Mr. Lewis, or indeed the owners, are not responsible for the condition of things, they had only been a few weeks in possession, and the manager very properly stopped the colliery, and no person has since worked there; and this seam of coal is now altogether abandoned. I consider the late owners, and their agents, have incurred great responsibility in ever allowing the works to get in the state it then was.

Explosions of powder.

I must once more point out the dangers arising from a want of care in the use of blasting powder, eight persons have been killed, and several others more or less seriously injured.

In one case, at Stoneyford Colliery, they were in the act of ramming the shot hole, when one of the men thinking the pricker was not sufficiently far in, knocked the end of it with his hammer, when it came in contact with some hard substance; an explosion was the immediate result: John Vickars was killed, and two others badly injured.

At Cinderhill Colliery a shot misfired, and instead of allowing some time to elapse before approaching the hole, Dennis Milward, a collier, insisted on going to see the cause of what he thought was a failure; when he got within a few yards of the hole the powder exploded and killed him.

Now this poor fellow had been cautioned by the fireman not to risk going, but to leave the place.

I have recommended the use of a copper pricker, and a wooden rammer, for stemming the first covering of the powder.

Never to try and drill out a shot hole, and not to go back for a considerable time after a shot has misfired.

There is, in my opinion, far too much powder used generally in getting coal; no doubt it saves trouble, it however, does great damage to the coal in blowing it small, and is always attended with more or less danger.

I hope the time is not far distant when the use of powder in mines, giving off gas, and working with safety lamps, will be a punishable offence.

Fines.

Proceedings have been taken against John Hall, of the Digby Colliery, Nottingham, for allowing a boy under age to work under ground. The poor lad was only eleven years of age; he fell in bringing loaded coal tubs to the shaft, and was killed. The magistrates fined Hall 10*l*. The general management of this colliery is most defective, no regard is paid to the observance of the special rules, and I thought it necessary, with your permission, to make an example of this person; Messrs. Shepherd and Smith were also summoned and fined for violations of the general rules.

Complaints.

Complaints have been received from colliers and others of the condition of some of the mines; they have always had my best attention, and all suggestions I have found necessary to make, have been carried out.

Boys under age are still employed in some of the collieries, but never I think with the consent of the owners; age is often misrepresented, and colliers take their sons into the mines with them without the knowledge often of the agent. At most of the collieries, schools are provided, but the difficulty is to get parents to send their children to them. Much remains yet to be done in the way of education, and no boy in these days ought to be allowed to enter a colliery until he can read and write.

Ironstone mines.

Two deaths by falls of roof, four in shafts, and one miscellaneous.

The shafts are on the outcrop of the coal field; they are often badly cased, badly fitted, and left in charge of young lads. The case of overwinding, happened in a "gin" pit; a boy tried to raise a man out of the shaft, and for a balance weight he filled a tub with bricks, it was however much too heavy, and the boy was overpowered, the loaded tub drew the man to the top, snapped the rope, and he fell to the bottom, and was instantly killed.

The number of collieries in this district are about 195; they are many of them of considerable depth, and in time, as the outcrop mines become exhausted, their places will be occupied by the deeper ones, of course presenting more danger, on account of their depth, and consequent large area of coal which will have to be worked from them; it may also reasonably be expected, that the undrained coal, will give off more inflammable gas, and generally, the opening out, and working of large collieries will require skilful and educated engineers.

Inspection of mines.

The extraordinary and rapid development of the coalfields of this country, the large increase in the quantity of coal raised, as well as the great area of coal necessarily worked from deep shafts, ought to be taken into consideration in estimating a comparative death-rate from accidents in mines. I am fully satisfied that, up to this, inspection of mines has been attended with beneficial results; but, as regards the important question of more frequent and more complete inspection, I am of opinion, having given the whole question my most earnest consideration, and having had a long experience as an Inspector, nearly thirteen years, that any great extension of the system of inspection will not be attended with good results; it will have the effect of relieving the owners and agents of that responsibility which properly belongs to them, and them alone. To make an inspector in any way responsible for the safety of the mine, there will have to be as many of them as there now are colliery viewers. The inspector is always in his district, ready to investigate accidents, and to give advice in any matter presenting a difficulty.

Possibly some of the districts may be too large; a re-arrangement of them, and the appointment of one or two additional inspectors, would, I believe, meet the present wants. No amount of inspection will prevent accidents altogether in an occupation attended with so much danger; all that can be done is to reduce them to the lowest possible point. Of late years, since the passing of the Mines Regulation Act, marked improvement has taken place in the management of mines, in the employment of better machinery, and in the generally more efficient ventilation of them.

I have, &c.
THOMAS EVANS,
Inspector of Mines.

The Right Hon. H. A. Bruce, M.P.,
Her Majesty's Principal Secretary of State, Whitehall.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS of LIFE arising therefrom, in the MIDLAND DISTRICT during the Year ending 31st of December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868. Jan. 1	1	Stanton - -	Burton-on-Trent	Nadin and Co. - -	Samuel Oliver -	Labourer -	15	Crushed between railway truck and screen.	—	—	—	—	1	1
,, 2	2	Shipley - -	Ilkeston - -	E. M. Mundy - -	Jonathan Moore -	Boy -	14	Run over on incline - -	—	—	—	1	—	1
,, 17	3	Cotmanhay -	Eastwood -	Barber, Walker, and Co. -	William Tunicliffe -	Collier -	36	Fall of bind from roof - - -	—	1	—	—	—	1
,, 17	4	High Park -	Eastwood -	Barber, Walker, and Co. -	Joan Murpher -	Sinker -	24	Fell off scaffold in shaft - -	—	—	1	—	—	1
,, 23	5	Morton - -	Clay Cross -	William Jackson, M.P. -	William Tracy -	Collier -	15	Fall of coal from side of heading	—	1	—	—	—	1
,, 28	6	Stoneyford -	Eastwood - -	John Wooley - -	John Vickars -	Ditto -	42	Explosion of blasting powder -	—	—	—	1	—	1
Feb. 6	7	Nesfield - -	Sheepbridge -	Sheepbridge Coal and Iron Company.	William Johnson -	Ditto -	38	Fall of roof - - - - -	—	1	—	—	—	1
,, 10	8	Hawkesbury -	Bedworth -	Hawkesbury Coal Company	Benjamin Knight -	Ditto -	41	Fell out of cage in coming up "the upcast shaft."	—	—	1	—	—	1
,, 20	9	Swannington -	Ashby-de-la-Z'ch.	William Worswick -	William Foster -	Ditto -	40	Run over underground incline -	—	—	—	1	—	1
,, 20	10	Shire-oaks -	Worksop -	Shire-oaks Company, Limited.	James Maycock -	Ditto -	16	Fall of roof - - -	—	1	—	—	—	1
,, 20	11	Victoria - -	Coventry -	Troughton and Co. -	Samuel Clark -	Banksman -	32	Run over on engine bank underground.	—	—	—	1	—	1
,, 25	12	Shipley - -	Ilkeston -	E. M. Mundy - -	John Limit -	Collier	27	Explosion of blasting powder -	—	—	—	1	—	1
,, 26	13	Granville -	Ashby-de-la-Z'ch.	Exors. of the late Cornt Grenville.	William Wignall -	Ditto -	32	Fall of coal badly supported -	—	1	—	—	—	1
Mar. 3	14	Swanwick - -	Alfreton - -	W. P. Moorewood -	George Legge - George Stephenson	Ditto - Ditto -	26 22	Explosion of blasting powder in hard ground - -	—	—	—	2	—	2
,, 18	15	Morton - -	Clay Cross -	William Jackson, M.P. -	William Grey -	Ditto -	25	Fall of bind - - - -	—	1	—	—	—	1
,, 20	—	Tibshelf - -	Alfreton - -	E. Chambers - -	Levi Lea - -	Labourer -	36	Railway truck run over him, not a colliery accident.	—	—	—	—	—	—
,, 27	16	Moorgreen -	Eastwood -	Barber, Walker, and Co. -	E. Bradley -	Sinker -	48	Fall of stone sinking shaft -	—	—	1	—	—	1
Apr. 15	—	Swannington, No. 4	Ashby-de-la-Z'ch.	William Worswick -	John Halfpenny -	Labourer -	31	Crushed by a railway truck -	—	—	—	—	—	—
,, 23	17	Swannington, No. 2	Ashby-de-la-Z'ch.	William Worswick -	Solomon Siddons -	Collier -	29	Fall of coal - - - -	—	1	—	—	—	1
,, 18	18	Renishaw Park -	Chesterfield -	J. and G. Wells - -	Henry Monks -	Boy - -	11	Run over by a railway truck -	—	—	—	—	1	1
,, 25	19	Hucknall - -	Nottingham -	Ellis and Co. - -	William Jackson -	Collier -	—	Fall of roof - - - - -	—	1	—	—	—	1

List of Fatal Colliery Accidents—*continued*.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owners or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.														
May 2	20	Wilnecote	Tamworth	Perrins and Harrison	Thomas Thomson	Boy	15	Run over on incline underground	–	–	–	1	–	1
„ 18	21	Cinderhill	Nottingham	Exors. of Thomas North	William Hardy	Collier	—	Explosion of gas	1	–	–	–	–	1
„ 20	22	Speedwell	Chesterfield	Staveley Company, Limited	John Beresford	Ditto	17	Fall of roof	–	1	–	–	–	1
„ 20	23	Sheepbridge	Chesterfield	Sheepbridge Company, Limited.	John Smith	Ditto	18	Fall of roof	–	1	–	–	–	1
„ 25	24	Old Hollingwood	Chesterfield	Staveley Company, Limited	Martin Ruddy	Ditto	34	Fall of roof	–	1	–	–	–	1
„ 28	25	Birchwood	Alfreton	Charles Seeley	John Sharp	Driver	13	Run over on incline underground	–	–	–	1	–	1
June 19	26	Swannington	Ashby-de-la-Z'ch.	William Worswick	Matthew Martin	Collier	29	Fall of stone from roof	–	1	–	–	–	1
„ 27	27	Lings	Chesterfield	Wingerworth Coal Company	John Winter	Incline rider	17	Run over on underground incline	–	–	–	1	–	1
July 2	28	Seymour	Chesterfield	Staveley Iron and Coal Company.	John Cross	Collier	19	Struck by the cage, passing under shaft contrary to orders.	–	–	1	–	–	1
„ 7	29	Danesmoor	Clay Çross	Smith and Shepherd	John Holmes	Ditto	28	Fell down shaft, defective machinery.	–	–	1	–	–	1
„ 16	30	Digby	Nottingham	Digby Colliery Company	William Vaeley	Driver	11	Run over, roads in a very bad state, badly supported.	–	–	–	1	–	1
„ 23	31	Nuneaton New Colliery.	Nuneaton	Nuneaton Colliery Company	Richard Rycote	Sinker	28	Explosion of blasting powder	–	–	1	–	–	1
„ 23	32	High Park	Nottingham	Barber, Walker	Fred Buxton	Collier	32	Fall of roof	–	1	–	–	–	1
„ 25	33	Ripley	Alfreton	Butterley Company	Thomas Parker	Ditto	22	Fall of roof	–	1	–	–	–	1
„ 30	34	High Park	Nottingham	Barber, Walker	Elijah Snow	Ditto	42	Fall of roof	–	1	–	–	–	1
„ 30	35	Clay Cross	Chesterfield	William Jackson, M.P.	John Price	Ditto	22	Fall of roof	–	1	–	–	–	1
Aug. 1	36	Whitwick	Coalville, Leicester	Exors. of J. Whetstone	William Holt	Loader	23	Fall of stone on main road	–	1	–	–	–	1
„ 3	37	Skegby	Mansfield	Skegby Colliery Company	John Reynolds	Engineman	19	Foot injured by an iron bar falling on it.	–	–	–	1	–	1
„ 5	38	Britain	Alfreton	Butterley Company	William Green	Driver	15	Fell out of cage part way down	–	–	1	–	–	1
„ 15	39	Cinderhill	Nottingham	Exors. of Thomas North	Dennis Milward	Collier	34	Explosion of blasting powder	–	–	–	1	–	1
„ 21	40	Victoria	Coventry	Throughton	Thomas Kimberley	Ditto	—	Fall of roof	–	1	–	–	–	1

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost. Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868. Aug. 25	41	Campbell - -	Chesterfield -	Staveley Iron and Coal Company.	Thomas Branson -	Enginewright	37	Fell down shaft whilst fixing pumps.	–	–	1	–	–	1
„ 27	42	Morton - -	Chesterfield -	William Jackson, M.P. -	Thomas Cooper -	Labourer -	30	Crushed by tub - -	–	–	–	1	–	1
Sept. 1	43	Denby - -	Belper - -	W. D. Lowe - -	Thomas Brown -	Pitman -	45	Fell off scaffold whilst fixing stays in shaft.	–	–	1	–	–	1
„ 16	44	Alma - -	Chesterfield -	Limited Company - -	John Lomas -	Inclineman	30	Run over on incline - -	–	–	–	1	–	1
Oct. 2	45	Swanwick -	Alfreton - -	W. P. Morewood - -	Albert Staples -	Collier -	—	Explosion of blasting powder -	–	–	–	1	–	1
„ 10	46	Ibstock - -	Leicester - -	Whetstone - -	Charles Boobier -	Driver -	13	Crushed by tubs - - -	–	–	–	1	–	1
„ 13	47	Charity - -	Bedworth - -	Addenbrooke and Pedcock	Richard Croft -	Collier -	36	Fall of roof - - -	–	1	–	–	–	1
„ 15	48	Nesfield - -	Chesterfield -	Sheepbridge Iron Company	George Lowe -	Ditto -	30	Fall of roof - - -	–	1	–	–	–	1
„ 21	49	Oakthorpe -	Ashby-de-la-Z'ch.	Exors. of Marquis of Hastings.	William Jones -	Ditto -	28	Fall of roof - - -	–	1	–	–	–	1
„ 23	50	Cotes Park -	Alfreton - -	James Oakes - -	Charles Heydom -	Inclineman	35	Run over on surface incline -	–	–	–	–	1	1
„ 23	51	Hawkesbury -	Bedworth -	Hawkesbury Coal Company	William Lea -	Collier -	19	Fell into shaft - - -	–	–	–	1	–	1
Nov. 4	52	Gresley - -	Burton-on-Trent	Gresley, Limited -	Edward Stanford - William Sherman -	Ditto - Ditto -	26 21	Suffocation by the gas given off from a spontaneous fire -	–	–	–	2	–	2
„ 2	53	Victoria - -	Coventry -	Troughton - -	George Irvin -	Ditto -	21	Run over - - - -	–	–	–	1	–	1
„ 5	54	Clay Cross -	Chesterfield -	William Jackson, M.P. -	Peter Kite -	Ditto -	25	Explosion of blasting powder -	–	–	–	1	–	1
„ 23	55	Newbold - -	Chesterfield -	C. H. Plevins - -	John Barnett -	Overman -	55	Fall of roof - - -	–	1	–	–	–	1
„ 26	56	Clay Cross -	Chesterfield -	William Jackson, M.P. -	G. H. Russell -	Driver -	14	Run over - - - -	–	–	–	1	–	1
Dec. 16	57	New Hollingwood	Chesterfield -	Staveley Coal and Iron Company.	Brigham Laxton -	Collier -	18	Fall of coal and clod - -	–	1	–	–	–	1
„ 24	58	Swannington -	Ashby-de-la-Z'ch.	William Worswick -	Fred Whittaker -	Ditto -	32	Fall of roof - - - -	–	1	–	–	–	1
								Total for the year -	1	24	9	23	3	60

LIST of the FATAL IRONSTONE MINE ACCIDENTS, and LOSS of LIFE arising therefrom, in the MIDLAND DISTRICT during the Year ending 31st of December 1868.

Date.	No. of Accidents.	Name of Mine.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868. Feb. 1	1	Morley Park	Belper	C. H. Disnay	John Refern	Miner boy	12	Fell down shaft ascending	–	–	1	–	–	1
„ 19	2	Walton	Chesterfield	Appleby and Co.	Jno. Adlington	Collier	53	Fall of the sides of the shaft	–	–	1	–	–	1
Apr. 15	3	Denby	Belper	Dawes	William Whiteman	Miner	23	Overwinding a gin pit	–	–	1	–	–	1
„ 20	4	Hungerhills	Chesterfield	Wingerworth Iron Company	William Raddish	Ditto	–	Fall of roof	–	1	–	–	–	1
„ 25	5	Charity	Bedworth	Addenbrooke and Pedcock	Rd. Wilkinson	Ditto	–	Fall of roof	–	1	–	–	–	1
Oct. 22	6	Ripley	Alfreton	Bullerley Company	George King	Driver	14	Fell down shaft	–	–	1	–	–	1
Dec. 8	7	Charity	Bedworth	Addenbrook	Thomas Ballin	Miner	22	Finger pinched, locked jaw	–	–	–	1	–	1
								Total	–	2	4	1	–	7

1st March 1869. THOMAS EVANS.

Mr. Wynne's Report.

REPORT on the INSPECTION of MINES for the DISTRICT comprising NORTH STAFFORDSHIRE, CHESHIRE, and SHROPSHIRE, for the Year ending 31st December 1868.

SIR, Stone, February 27th, 1869.

I HAVE the honour to report to you my proceedings as an Inspector of Mines during the year 1868, and in doing so will endeavour to point out some of the defects in the practice of mining which have led to serious loss of life; and although the list of accidents and deaths will bear a comparison with many former years, yet it is not what it ought to be, and what it would be if stricter discipline were enforced in the pits, and a compliance with the rules more rigidly required; for it rarely happens that an enquiry into the cause of an accident takes place, without revealing some extremely bad discipline, or some gross disregard of one or more of the special rules. Indeed there are but a few collieries where these rules are properly enforced.

Explosions of Fire-damp

Have not been so frequent or so fatal as in former years. Seven fatal explosions have happened, by which nine persons lost their lives. Two of these occurred at the Lilleshall Company's Works, one on the 24th January in a sinking pit, and one on the 25th September of rather a serious nature. It appeared that the pit had been "laid by" for a few days, and the furnace let out whilst the upcast shaft was repaired, and whilst this was being done some water had accumulated in a low part at the far end of the workings, which was to be drawn out on the 25th; but Pickering, one of the deceased, hired a strange man to go with him on the 24th, and when they had finished their work and closed the doors the gas followed them and fired at their naked lights. Had the charter master obeyed the instructions given him "not to send the pony down until the 25th," the deceased men would not have gone, and all would have been right, as the men in a lower seam were preparing to light the furnace fire when this happened.

The next most serious one was at Oldfield Colliery, near Longton, on the 7th July, and I cannot put the case clearer than by giving an epitome of David Booth's evidence at the inquest. He said, "I have been a butty some years under my father. I told Corbett the underlooker, when he was last in the pit, that there was gas in the old drum road, level with the drift; I told my father as well many a time; I told him we were short of ventilation, and ought to have a fire at the Ash coal. He said he had told Corbett, but I was not present when he did so; there were about 12 yards of gas and about a foot thick in the goaf. I fired three shots that morning; there was an explosion after the last shot, and soon after another explosion that burned us all." Here they were using lamps as a safeguard against the gas in the goaf; but it is a complete farce to use locked lamps and at the same time allow shots to be fired in the most dangerous parts of the mine, or indeed to use powder at all where lamps only are allowed.

On the 11th July three men were timbering a road at Madeley Wood Colliery, and although they knew there was gas in the "pothole" above them, placed their candle in the way the gas must travel, and when they threw the dirt up it displaced the gas and burnt two of the men. Now the simplest care and precaution in this case would have saved these men.

Falls of Coal and Roof.

Under this head I am sorry to say there is no improvement, 28 accidents having caused the death of 28 persons, which is much in excess of what it ought to be, and it is mainly owing to neglect of the 18th special rule, and the want of some one directly employed by the owner to see that timbering is regularly and properly done; for it is due to them to say that in nearly every case the supply of timber is proved to be plentiful and of good quality, but the failure is in want of discipline and care on the part of the workmen. The butty says to his men, "Now lads, mind and keep yourselves safe," and then leaves them, and goes to look after that part of his business which has by some means or other to be made profitable. Now if the butty system must still prevail, the owner ought to employ a man in every pit, independent of the butty, to see to the safety of the men, and to send men out of the pit if they will not obey the rules, as an example to the other workmen; but now that it is entirely left to the butty, he is far more likely to look over their faults than suffer pecuniary loss by losing their labour. Then and not till then shall we see this class of accidents materially reduced.

In shafts.

When reporting on the year 1867, I said, "The loss of life under this head is discreditable," and drew a comparison between my district and Durham; and I am happy to say the reproach is somewhat lessened in its force, by reducing the number who have lost their lives, from 20 in 1867, to 10 in 1868, a number still in excess of what it ought to be. Three men lost their lives at Kidsgrove by the breaking of a wire rope, owing to the use of a wire rope under circumstances totally unfit for the application of that material, the drum being 4½ feet, and the pulley only 4 feet; and to hasten the crisis the rope was taken off the drum and got a "kenk" from some irregular coiling. There have been three cases of falling from mouthings, and each may be attributed to the want of knowledge on the part of the managers, who prefer the old and rude mode of winding with half scaffolds at the mouthings, to the simple and safe mode of guides and cages. Two cases have occurred of falling into shafts from the pit bank, one of which was sent to Stafford Assizes to be enquired into, but as usual the feeling prevailed "that the prisoner did not do it on purpose," and he was of course acquitted. This case arose at Mr. Heath's Colliery at Norton, where the banksman believing the cage was as usual over the pit mouth, walked backwards with his tub behind him; but in the meantime the engineman neglecting his duty allowed the engine to "creep" and raise the cage about 4 feet, or sufficient to allow the poor fellow to walk backwards into the pit. This case showed more clearly than usual how anxious all parties are at first to fix the blame on the right person, so that nothing comes of it; but when the coroner's jury found a verdict of manslaughter, reaction set in, and all parties, from the owner downwards, were ready with excuses for the culprit that were not even hinted at before. The other cases call for no particular remarks, but it is to be hoped that all persons in authority will see that most of these accidents are preventible; and use their best endeavours to make them of very rare occurrence.

Miscellaneous Underground.

Under this head the number is the same as the year before, and much of the same character, trams and tubs doing the mischief that gunpowder and inclines have not done. However singular I may appear in giving such an opinion, every inspection convinces me more and more that the use of powder in coal mines is a mistake, and the sooner the use of it is prohibited the better it will be for all parties; many men are killed by it, but far more are maimed for life. One half of the explosions of fire-damp are traceable to firing shots, and a vast number of accidents from falls of roof are caused by the shattered condition of shale roofs after blasting to the extent now practised. There seems a growing disposition to employ persons of more mature age on inclined planes, which will tend to prevent accidents, and be found more profitable, owing to the greater regularity in keeping up the supply of coal. Two accidents have occurred through falling down "staple pits," which is rather unusual in this district, but in neither case did any serious blame attach to any one but the deceased themselves, who were trying to do without help work that required assistance.

On Surface.

One of the most serious boiler explosions that we have had for many years occurred at Shelton Colliery on the 31st July, and although part of the boiler was carried several hundred yards, and fell in the Shelton Bar Iron Works, only one person lost his life. It appeared that all the boilers at the colliery were under the inspection of Mr. E. B. Martin and his assistants, and that it had been reported as defective but always repaired at once; which shows that no boiler is equal to a great pressure of steam, after once it shows great symptoms of wear and tear leading to leakage. The three cases where lives have been lost by machinery, are due to want of care in the management of such machinery. In the first case the engineman must have been asleep, and drew the water barrel over the pulley at such speed that it went over the engine-house, falling on a man who was lying between the boilers. In the second a boy was climbing over a part of the engine, and fell between the cog-wheel and pedestal. And in the third the engine-man was lifting at the flywheel to start it over the centre without placing any one to control the engine when it started, and the steam being full on, the man was thrown into the race and crushed by the flywheel.

Ironstone Mines.

The accidents in this class of mines are not on the increase, but it requires the utmost care and watchfulness on the part of persons in charge of ironstone workings to prevent men running great risks; for where the coal and stone are from 5 to 8 feet thick, the fall of a small piece of stone on a man is almost certain death; and the temptation is also great when in bringing back pillars they see the crush of the roof on the pillars getting the stone ready for them, and only requiring extra risk and daring to make it profitable though hazardous work. At the Old Park in Shropshire, they drove up from the new mine coal level into the white flats ironstone, a rise of 30 feet, and brought the air from an old level in an air-pipe to the entrance of this place, but took no precautions to prevent the air from returning to the upcast shaft; and although the men were working at the top of this rise, 20 yards beyond the air, and with a face of work 30 or 40 yards long, the colliery manager seemed astonished that an explosion of fire-damp should occur; and when I summoned the principal agent for a breach of the 1st general rule, he called the manager and the consulting viewer to prove that the place was exactly in the state that it ought to be in; but the magistrates did not concur in this nonsensical view of the case, and fined the agent £15 and expenses.

The subject of the education of miners' children will, I hope, again be brought prominently forward and something be done to fix the responsibility of allowing boys under age to work in mines on the parents, who well know the age of their children and should be held responsible for the education and proper training of their boys. Whenever I see a boy in the pit whose age appears doubtful, the answer to my question is, "Oh I'm just turned 12," from which the inference may be drawn that they are pretty well schooled on that subject.

I have, &c.
THOMAS WYNNE,
Inspector of Mines.

The Right Hon. H. A. Bruce, M.P.,
Her Majesty's Principal Secretary of State.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS of LIFE arising therefrom, in the NORTH STAFFORD, SHROPSHIRE, and CHESHIRE DISTRICT, during the Year ending 31st December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost. Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868. Jan. 6	1	Coed-y-goe	Oswestry	W. O. Savin	T. Jones	Stoker	40	The water barrel drawn over pulley fell on deceased.	–	–	–	–	1	1
„ 9	2	Talke-o'-th'-Hill	Newcastle	North Stafford Coal Company.	H. Jones	Waggoner	21	Tub got loose on jigbrow and crushed him.	–	–	–	1	–	1
„ 14	3	Granville	Wellington	Lilleshall Company	A. Hayward	Ditto	13	Waggon went over him on the road	–	–	–	1	–	1
„ „	4	Leycett	Newcastle	Crewe Coal Company	D. Pearson	Manager	60	Drum got loose from driving wheel	–	–	1	–	–	1
„ 18	5	Apedale	Ditto	Apedale Company	Peter Ryley	Collier	—	Fall of coal	–	1	–	–	–	1
„ 30	6	Bucknall	Hanley	Bucknall Company	C. Bailey	Labourer	—	Fell 28 feet into sinking pit whilst pumping.	–	–	1	–	–	1
Feb. 3	7	Lilleshall	Wellington	Lilleshall Company	Jas. Hicks	Sinker	43	Explosion of fire-damp	1	–	–	–	–	1
„ 6	8	Bollington	Macclesfield	Jno. Vere	W. Hordern	Collier	30	Explosion of a shot	–	–	–	1	–	1
„ 21	9	Adderley Green	Longton	Stirrup and Pye	S. Rhodes	Loader	33	Fall of roof	–	1	–	–	–	1
„ 29	10	Clough Hall	Newcastle	Kinnersley and Co.	J. Foden & 2 others	- - -	—	Rope broke whilst ascending	–	–	3	–	–	3
„ „	11	Hayes Wood	Ditto	Burgess and Procter	T. Farrington	Collier	—	Fall of coal	–	1	–	–	–	1
Mar. 12	12	Poynton	Stockport	Lord Vernon	J. Hill	Ditto	38	Fall of roof	–	1	–	–	–	1
„ 25	13	Adderley Green	Longton	Stirrup and Pye	J. Gould	Ditto	—	Fall of coal	–	1	–	–	–	1
„ 31	14	Madeley Wood	Ironbridge	Anstice and Co.	T. Parker	Driver	13	Crushed by a waggon in the level	–	–	–	1	–	1
„ „	15	Stonetrough	Tunstall	Williamson, Brothers	J. Conway	Collier	44	Fall of roof	–	1	–	–	–	1
Apr. 2	16	Woodshutts	Newcastle	Woodshutts Company	W. Wood	Boy	—	Crushed by cog wheel	–	–	–	–	1	1
„ 6	17	Madeley Wood	Ironbridge	Anstice and Co.	W. Taylor	Ditto	—	Fall of roof	–	1	–	–	–	1
„ 9	18	Apedale	Newcastle	Apedale Company	J. Johnson	Collier	50	Ditto	–	1	–	–	–	1
„ „	19	Norton	Burslem	R. Heath	Jno. Baker	Banksman	50	Fell down the pit	–	–	1	–	–	1
„ 22	20	Lilleshall	Wellington	Lilleshall Company	M. Bradley	Ditto	—	Fall of roof	–	1	–	–	–	1
„ 25	21	Greenfield	Tunstall	W. Adams	J. Stannaway	Collier	43	Suffocated by carbonic acid gas	–	–	–	1	–	1
May 1	22	Moss Fields	Longton	Hawley and Co.	Jno. Price	Ditto	44	Fell from a mouthing	–	–	1	–	–	1
„ 5	23	Norton	Burslem	R. Heath	M. Massey	Hooker-on	—	Crushed under the cage	–	–	–	1	–	1
June 1	24	Silverdale	Newcastle	Silverdale Company	Jno. Perry	Ditto	—	Fall of roof	–	1	–	–	–	1
„ 17	25	Ditto	Ditto	Ditto	T. Massey	Loader	19	Fall of coal	–	1	–	–	–	1
„ 19	26	Billingley	Bridgnorth	W. Breakwell	J. Berry	Boy	—	Fell off the skep whilst ascending	–	–	1	–	–	1
„ 29	27	Dunkirk	Dukinfield	Dunkirk Company	J. Percival	Collier	35	Fall of roof	–	1	–	–	–	1
July 7	28	Oldfield	Longton	T. Goddard and Sons	J. Booth & another	Ditto	—	Explosion of fire-damp	2	–	–	–	–	2
„ 9	29	Shelton	Hanley	Earl Granville	Jno. Keen	Ditto	42	Fall of coal	–	1	–	–	–	1

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost. Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.														
July 16	30	Blakelow	Hanley	Simpson and Blakie	R. Edwards	Collier	28	Fall of coal	—	1	—	—	—	1
„ 23	31	Talke-o'-th'-Hill	Newcastle	North Stafford Coal Co.	J. Cooper	Driver	13	Fell down a staple pit	—	—	—	1	—	1
„ 24	32	Madeley Wood	Wellington	Anstice and Co.	R. Griffiths	Collier	35	Explosion of fire-damp	1	—	—	—	—	1
„ 31	33	Shelton	Hanley	Earl Granville	W. Shaw	Stoker	19	Explosion of a boiler	—	—	—	—	1	1
Aug. 27	34	Norton	Burslem	R. Heath	W. Slater	Collier	48	Fall of roof	—	1	—	—	—	1
Sept. 1	35	Ketley	Wellington	Ketley Company	Jno. Jones	Driver	13	Fell off waggon and crushed	—	—	—	1	—	1
„ 11	36	Norton	Burslem	R. Heath	S. Sherratt	Ditto	22	Ditto	—	—	—	1	—	1
„ 25	37	Lilleshall	Wellington	Lilleshall Company	A. Pickering and another.		—	Explosion of fire-damp	2	—	—	—	—	2
Oct. 3	38	Podmore Hall	Newcastle	Woodshuts Company	G. Sumnall	Driver	16	Fall of roof	—	1	—	—	—	1
„ 5	39	Norton	Burslem	R. Heath	J. Clewlow	Collier	62	Fall of coal	—	1	—	—	—	1
„ 10	40	Mear Heath	Longton	W. H. Sparrow and Son	Jno. Perry	Ditto	26	Fell under tub on incline	—	—	—	1	—	1
„ 13	41	Adlington	Macclesfield	Leigh	Chas. Walton	Ditto	21	Fall of roof	—	1	—	—	—	1
„ 16	42	Silverdale	Newcastle	Silverdale Company	J. Scott	Ditto	21	Ditto	—	1	—	—	—	1
„ 19	43	Bycars	Burslem	Exors. of Wedgwood	D. Clews	Ditto	46	Ditto	—	1	—	—	—	1
„ 20	44	Apedale	Newcastle	Apedale Company	J. Higginbottom	Ditto	29	Fall of coal	—	1	—	—	—	1
Nov. 1	45	Norton	Burslem	R. Heath	W. Knight	Labourer	38	Fell into race whilst lifting the wheel.	—	—	—	—	1	1
„ 5	46	Adderley Green	Longton	Stirrup and Pye	Peter Merry	Collier	23	Fall of coal	—	1	—	—	—	1
„ 7	47	Jackfield	Burslem	Plant and Co.	J. Capewell	Loader	23	Fell from a mouthing	—	—	1	—	—	1
„ 21	48	Kingsley	Cheadle	Jno. Carr	J. Carr	Sinker	—	Fell off scaffold	—	—	1	—	—	1
„ 23	49	Sneyd	Burslem	C. and J. May	D. McNicholas	Loader	36	Fall of roof	—	1	—	—	—	1
„ 26	50	Berry Hill	Hanley	W. Bowers	T. Poyser	Collier	45	Explosion of fire-damp	1	—	—	—	—	1
Dec. 1	51	Dawley	Wellington	Coalbrookdale Company	G. Richards	Ditto	53	Fall of roof	—	1	—	—	—	1
„ 9	52	Oldfield	Longton	T. Goddard and Sons	R. Bridge	Butty	42	Ditto	—	1	—	—	—	1
„ 13	53	Bentilee	Ditto	Hawley and Co.	W. Johnson	Collier	40	Explosion of fire-damp	1	—	—	—	—	1
„ „	54	Berry Hill	Stoke	W. Bowers	G. Emery	Ditto	42	Fall of coal	—	1	—	—	—	1
„ 21	55	Glebe	Fenton	Challinor and Co.	T. Lee	Ditto	45	Explosion of fire-damp	1	—	—	—	—	1
„ 24	56	Dawley	Wellington	Coalbrookdale Company	R. Jenks	Ditto	—	Fall of roof	—	1	—	—	—	1
„ 28	57	Lightmoor	Ditto	Ditto	G. Clarke	Driver	15	Ditto	—	1	—	—	—	1
								Total	9	28	10	10	4	61

LIST of the FATAL IRONSTONE ACCIDENTS, and LOSS of LIFE arising therefrom, in the DISTRICT of NORTH STAFFORD, SHROPSHIRE, and CHESHIRE, during the Year ending 31st December 1868.

Date.	No. of Accidents.	Name of Mine.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868. Jan. 17	1	Lawley	Wellington	Coalbrookdale Co.	T. Morris	Driver	16	Fall of roof in the road	–	1	–	–	–	1
" 20	2	Donnington	Ditto	Lilleshall Co.	M. Tonks	Miner	21	Fall of roof	–	1	–	–	–	1
" 24	3	Dawley	Ditto	Coalbrookdale Co.	J. Corbett	Driver	12	Fall of roof in the road	–	1	–	–	–	1
" "	4	Millbank	Newcastle	J. H. Pearson	J. Browning	Miner	66	Fall of roof	–	1	–	–	–	1
Mar. 18	5	Chatterley	Tunstall	Chatterley Co.	T. Foster	Ditto	28	Fell down a staple-pit underground	–	–	–	1	–	1
April 7	6	Ditto	Ditto	Ditto	Jno. Roberts	Ditto	41	Fall of ironstone	–	1	–	–	–	1
" 9	7	Ditto	Ditto	Ditto	T. Porter	Sinker	—	Fell out of bowk whilst descending	–	–	1	–	–	1
May 12	8	Chell	Ditto	R. Beswick	W. Evans	A boy	—	Fall of roof	–	1	–	–	–	1
" 14	9	Priorslee	Wellington	Lilleshall Co.	Chas. Hassall	Miner	28	Ditto	–	1	–	–	–	1
" 17	10	Old Park	Ditto	Old Park Co.	H. Horton	Labourer	35	Fall of earth in an open work	–	–	–	–	1	1
June 8	11	Lilleshall	Ditto	Lilleshall Co.	H. Tonks	Hooker-on	16	Held the hook and ascended 5 yards, and fell.	–	–	1	–	–	1
" 11	12	Silverdale	Newcastle	Silverdale Co.	G. Dean	Driver	30	Crushed in road whilst riding	–	–	–	1	–	1
" 25	13	Chesterton	Ditto	Chesterton Co.	Jno. Briggs	Miner	40	Fall of stone	–	1	–	–	–	1
July 14	14	Chell	Tunstall	R. Beswick	J. Hancock	Ditto	37	Ditto	–	1	–	–	–	1
Sept. 12	15	Sneyd Green	Burslem	Silverdale Co	H. Beech	A boy	14	Crushed on a *jig*	–	–	–	1	–	1
" 15	16	Newchapel	Tunstall	R. Heath	Jno. Lindop & ano^{r}.	- - -	—	Premature shot in sinking pit	–	–	–	2	–	2
" 24	17	Madeley Court	Wellington	W. O. Foster	Jno. Beech	A boy	13	Held the hook, and drawn part way up shaft.	–	–	1	–	–	1
Oct. 17	18	Foley	Longton	T. Goddard & Sons	F. Humphries	Miner	26	Explosion of fire-damp	1	–	–	–	–	1
Nov. 2	19	Silverdale	Newcastle	Silverdale Co.	H. Sherratt	Ditto	20	Fall of stone	–	1	–	–	–	1
Dec. 23	20	Old Park	Wellington	Old Park Co.	Jno. Rogers	Ditto	40	Explosion of fire-damp	1	–	–	–	–	1
								Total	2	10	3	5	1	21

NUMBER and NATURE of FATAL ACCIDENTS to PERSONS employed in and about COAL MINES and COLLIERIES in the District comprising NORTH STAFFORD, SHROPSHIRE, and CHESHIRE, during the Years 1864, 1865, 1866, 1867, and 1868.

Year.	—	Explosions of Fire-damp.	Falls in Mine.			In Shafts.									Miscellaneous Underground.									On Surface.				Gross Totals.
			Falls of Coal.	Falls of Stone.	Total Falls in Mines.	Overwinding.	Ropes and Chains Breaking.	Whilst ascending or descending.	Falling into Shaft from Surface.	Things falling from Surface.	Falling from part way down.	Things falling from part way down.	Miscellaneous in Shafts.	Total in Shafts.	Explosions of Gunpowder	Suffocation by Gases.	Irruptions of Water.	Falling into Water.	On Inclined Planes.	By Trams and Tubs.	By Machinery Underground.	Sundries Underground.	Total { Miscellaneous Underground.	By Machinery on Surface.	Boilers Bursting.	Miscellaneous on Surface.	Total on Surface.	
1864	Number of Accidents - - -	13	4	9	13	–	2	1	4	–	3	1	–	11	1	1	–	–	1	2	–	–	5	2	–	1	3	45
"	Number of Deaths - - - -	22	4	9	13	–	2	1	4	–	3	1	–	11	1	1	–	–	1	2	–	–	5	2	–	1	3	54
1865	Number of Accidents - - -	6	9	13	22	2	1	1	2	–	2	–	–	8	1	–	–	–	2	2	1	1	7	2	–	–	2	45
"	Number of Deaths - - - -	12	9	13	22	2	1	1	2	–	3	–	–	9	1	–	–	–	2	2	1	1	7	2	–	–	2	52
1866	Number of Accidents - - -	9	3	8	11	–	–	2	3	–	3	2	–	10	–	–	–	–	5	5	–	2	12	1	1	3	5	47
"	Number of Deaths - - - -	142	3	8	11	–	–	2	3	–	3	2	–	10	–	–	–	–	5	5	–	2	12	1	2	3	6	181
1867	Number of Accidents - - -	11	10	15	25	–	2	4	5	1	3	–	–	15	3	–	–	–	4	2	–	1	10	–	–	–	1	61
"	Number of Deaths - - - -	17	10	17	27	–	3	7	5	2	3	–	–	20	3	–	–	–	4	2	–	1	10	–	–	–	1	74
1868	Number of Accidents - - -	7	10	18	28	–	1	2	2	–	3	–	–	8	1	1	–	–	2	4	–	2	10	3	1	–	4	57
"	Number of Deaths - - - -	9	10	18	28	–	3	2	2	–	3	–	–	10	1	1	–	–	2	4	–	2	10	3	1	–	4	61

Mr. Brough's Report.

Report of the Working of the Mines Inspection Act (23 & 24 Vict. c. 151.) for the South-western District, during the year ended 31st December 1868.—By Lionel Brough, Esq., F.G.S.

Sir, Clifton, 27th February 1869.

I have the honour to remit, as required by the twenty-seventh section, the report for 1868 on the working of the Mines Regulation and Inspection Act of Parliament, 23 & 24 Victoria, cap. 151. Also, I beg to enclose the lists, fatal and non-fatal, of all the casualties that were notified to me throughout the entire year in the South-western Division of coal mines.

The death record, I am glad to say, is considerably reduced, the number of the killed gradually descending from eighty-two in 1865 to sixty-one in 1868, every succeeding year having been attended with decrease. This statement evinces itself in a still more marked manner when tested by the proportional calculation of quantity of coal to a single death: 1868 shows 101,639 tons, whilst in the previous year it stood at the less favourable ratio of 91,549 tons, a difference of more than 10,000 tons; and but for a prolonged "turn out" in a portion of the district, the "get" of coal would have been larger, and the results most probably would have been better just in that corresponding degree. These "strikes" inflict irreparable injury on colliery proprietors, on the workmen themselves, and on whole communities.

Commencing with "explosion of fire-damp," I beg permission to say, that that class of accident exhibits diminution in a most especial manner, one person only having been killed in all the year, and even that event should not by any means have taken place; it was a blunder, and had its source in ignorance. But one death by carburetted hydrogen in so fiery a district, is at the same time unusual and encouraging. Notwithstanding this good result we must continue to be unrelaxing, and leave no exertion unattempted, either legal or technical, to fight against this scourge to the coal miner. Amongst other efforts I would recommend that, in any new enactment, the three words "under ordinary circumstances" be omitted; that would render clear and distinct the first general rule of the present statute, and in my opinion would contribute to the saving of human life. Another great step would be to abandon altogether the use of gunpowder for the bringing down *of coal* in mines liable to fire-damp. Furthermore, air in abundance, no stint of safety officers, and the selection of the best possible class of safety lamps, are all most essential provisions. On this latter subject it is needful to state, that if at the speed of eight feet per second an ordinary "Davy" (and some lamps of other kinds) will pass the flame, then indeed our confidence becomes rudely shaken. But we must remember, that though eight feet per second is a rate of travel of the air often arrived at in the intakes (and even still more than that) of fairly ventilated collieries, it is by no means the fact that explosive mixtures are always met with passing at such a high speed, unless it be gas from some tremendous blower, and even that requires some little space of time to mix it up to the highest point of danger. Nevertheless, the able experiments lately entered into underground in the North, give rise to serious thought, and demand especial care in the use of the "Davy," or indeed, for that matter, of any other sort of lamp at present in use in all Britain.

The next column we come to embraces "falls of coal and stone," and I am sorry to say it undergoes no mitigation whatever in my district. Forty-three men and boys perished by this never-ceasing cause of disaster, whereas in 1867 only thirty-nine deaths occurred.

The return of lives lost by "falls" from the twelve districts of the kingdom in 1868, in collieries and in ironstone mines, unfortunately comes up to 484. Fire-damp itself, frightful as it is, very rarely indeed approaches any such record as this. When next the Act of Parliament undergoes revision, I trust a general rule will be added of a kind fully equal to the reduction of such vast destruction of life; or, full power be given for a special rule to the same effect, to be framed of course in accordance with the nature of the stratification, not only of the district at large, but also of the varying parts of it, and even of each individual colliery. The opponents of change charge the Inspectors with making complaint of the loss of life by "falls," but say that they never propose a remedy. My reports at any rate contain suggestions to that effect as regards my own district. I have from time to time recommended the northern method of propping (that by the deputies); I have advised closer timbering; indeed, I have gone so far as to propose a stipulated number of supports per given area, whether the roof be strong or tender; it cannot therefore be said that I have failed to suggest remedial measures.

The mode of each person's death is distinctly and practically explained in the enclosed "Lists" therefore I need not make further observations on the lamentable loss of life by "falls of coal and stone," or quote any of the numbers of that fatal column here in the body of this report; there are far too many of them for exemplification.

The third record in the list is dedicated to death in "pit-shafts." I am thankful to say that only five took place in the year under notice; in 1867 exactly double that number of persons lost their lives from such cause.

An accident belonging to this column (enumerated in the list as 21) occurred at the Mells Colliery, near Frome, on the third of April, to John Cary, and requires far more comment than can be awarded to it in the mere "list." There is a "brow" some yards above the bottom inset of the pit, and Cary was the last of five persons that entered the cage in order to go to the surface, but instead of that they commenced to *descend*, and the cover caught the young man's leg before he was fairly inside, and so injured him that he soon afterwards died. At the inquest, a verdict of manslaughter was recorded against the bottom onsetter, and a true bill was found by the grand jury at the ensuing Wells assizes. However, when the man was put on his trial, the judge stated,—that having perused the evidence before the coroner, and especially that of the Government Inspector of Mines, he had observed that he then and there deposed that there existed at that particular pit "a complicated code of signals;" under these circumstances he (the judge) did not think the case could proceed further, whereupon the onsetter was liberated without evidence having been gone into at all, and so the proceedings entirely terminated. I quote the above number of the list, to show the necessity of proper signals. Moreover, I beg permission to state my opinion,—that intermediate "brows" in pit-shafts are most objectionable in that particular portion of my district, or indeed in any other, if they can but be reasonably avoided. Simple, clear, distinct signals would save many a life: this I have stated in most of my annual reports, never failing also to point out that we require *large* shafts, well lined from top to bottom; most abundant steam power; extremely strong ropes, with drums and pulleys of great diameter; high pit framing, and accurate "load indicators." These are some of the elements of human safety, as far as shafts are concerned.

Another pit accident must not be omitted, No. 24 of the list. The steam power was most limited, and of course not equal to large drums and strong ropes. The one that broke had been too long at work, and had become much deteriorated; the scaffold, under which two men were unfortunately then in the bottom of the shaft, was so thin and badly constructed as to offer no resistance to the accelerated descent of a ponderous body; so, when the inefficient rope snapped, the major portion of it crashed through the scaffold, and killed one of the above-mentioned persons, and at the same time injured the other, indeed it was almost a miracle that he contrived to escape at all. The whole arrangements were of such a miserable character, that, at the inquest, the jurors exhibited the strongest possible tendency to record manslaughter; however, guided by the coroner, they arrived at a less onerous conclusion.

There has been much ingenuity displayed for some years past in apparatus of divers kinds to act effectually when a rope breaks, and some of the methods arrived at are, no doubt, worthy of praise. But, in this class of accident, as in the employment of safety lamps in fiery mines, the contingency may arrive that neglect ensues; in the case of the lamps it may possibly give rise to restricted air passages, and equally so with the other life-preserving inventions there may ensue an indifference as to the integrity of the pit ropes, or, lulled into a feeling of security, to the efficacy of the patent machinery itself, and then perhaps may arrive a great calamity. In my opinion, there are no life-saving means that surpass vast initial strength in the usual winding apparatus itself. I prefer this open and straightforward method to the use of contrivances whose very principle may render them liable to entanglement and derangement.

It is absolutely necessary to be alive to all improvements and new processes, and to a certain extent to exert ourselves to help on that which we believe to be beneficial. But, practical knowledge alone can be relied on; experience always upsets mere theory.

However, it is but just to observe, that if an invention really possesses merit and originality it is sure of final success, in the end it cannot fail to be generally adopted. But I must repeat, that in abundant original force will be found the maximum means of safety. Even this should be accompanied by great sectional area in the pit, for there must be room for the plenitude of power. And, besides, there ought always to be a *sufficient number* of shafts; in the end it will be found, not only safer, but far more economical than putting all the strain on one, or even on two openings. It was at one time feared that Legislative interference on the point of additional shafts would extinguish the existence of many collieries. It does not appear, however, that the Act of Parliament 25 & 26 Vict. c. 79. (passed in 1862) has had that effect; on the contrary, since that measure came into operation, there has been as much and even more elasticity in the coal trade than ever there was before.

The last underground column in the list is headed "Miscellaneous," and I have much pleasure in stating that here again diminution is to be observed: in 1868, eleven persons were killed by this class of accident, whereas, during the previous year, fourteen unfortunately lost their lives from similar causes.

Entanglement by chains on inclines, the breaking of engine bank ropes, the crush of trams in levels, cross-headings, and stalls, and the careless or ignorant use of gunpowder, are the leading accidents under this head. With regard to persons getting seriously, and too often fatally crushed, I can only say that in my district many of these levels and cross-heading are narrow, the trams that are used are large and heavy, and casualties are thus continually brought about, often added to by the employment of hauliers too young and weak to "back" and "shaft" those ponderous vehicles on headings of considerable and varying gradients. It is not as in other parts, where the tub and its load is not *half* the weight that it is in Monmouthshire, Breconshire, and Glamorganshire; in the North of England young drivers are adaptable because of the habitual light loads there, but not so in the division of mines under my charge. Then, again, the taking away by these very hauliers of the young trappers with them, far from their doors, is a practice that I altogether protest against. Since I have been in the district my lists will show that the lives of very many of these mere tender children have been so sacrificed; however, as every one of my previous reports bear witness against this pernicious mode of employing the door boys, I need not now make further comment on the subject. If all collieries were laid out for the "tail-rope system" of transporting products underground, the killing of hauliers and other young persons, and the wearing out and destruction of poor horses, would be greatly lessened indeed.

Gunpowder, I regret to say, has caused the death of four persons out of the eleven of the "miscellaneous accidents." The first of these is No. 19 of the list:—A workman (probably an unskilled one), whilst ramming his charge, approached his candle so near to the shot hole as actually to ignite the powder. The second is No. 31:—A boy had got hold of some loose powder to which he had no claim whatever; then he had not the patience to wait till his day's work was finished, but actually began to amuse himself with the powder underground, when a portion of it that was in his pocket somehow or other became ignited, and so severely burned him that he did not long survive.

The third and last of these cases is No. 55, and is indeed a very painful instance of the improper use of gunpowder. Two men worked in a thin seam of coal, and powder was supplied to them to blast the hard top with to make room for the tubs, but they were especially ordered on no account whatever to waste it in coal; notwithstanding this they did put a shot hole in the seam, but they managed the job so unskilfully that the whole can of powder, two or three pounds in weight, ignited and burned them so dreadfully that they died some days after the accident. If men will kill themselves by disobedience to rules and orders, it is hard on owners, managers, and inspectors.

In the non-fatal list under this head are to be found several cases of the inconsiderate handling of this dangerous compound, and, what is worse, the use of steel prickers or needles: it is surprising the number of accidents throughout the kingdom that take place every year in consequence of the employment of steel implements instead of copper. Of course many of the tools must be of steel, but the pricker, the instrument most likely to do mischief, should invariably be made of copper. Then, also, the workmen are sometimes careless about fuses, and often do not use the right sort.

I now beg permission to quote two instances of the burning by gunpowder, but unaccompanied with fatal results:—Four or five persons had drilled a hole underground and charged it, they then hung up the tin of powder (some pounds in weight) on the rib exactly opposite the mouth of the shot hole, and not many feet from it. When they fired the shot the flame flew to the tin and ignited the powder; that was a matter of course, but the stupidity of the act is really astounding. Thus it is, that the inspectors' lists, both fatal and non-fatal, get filled up and swollen by childish and inconsiderate conduct: men ought to be ashamed of such follies, it is bad enough in mere boys, as the following instance will show.

In the No. 4 pit at Sirhowy a youth was emptying from a paper parcel about three pounds of powder into a tin, when, his father observed that many of the grains were scattered on the floor of the mine, and instantly removed his son's candle further back, and after that went in bye to his own working place. The boy then took the candle and positively set fire to those very grains, and the flash from them ignited the whole bulk of the powder, which he held in his other hand, and burned him most dreadfully. The special rules will have to be altered respecting gunpowder, and made very severe; I do not know any other way to check these worse than follies.

The last of all the five columns belongs to the surface, and No. 30 of the list is the case of a haulier falling under his tram whilst taking coal from the top of the pit. Crush of trams *underground* but too readily takes place in narrow roads and with a feeble light; however, on the surface such an accident is certainly far more preventible, as it is in the daylight, therefore for that very reason the more to be deplored, because in the case under notice death evidently arose from carelessness.

A shocking fatality occurred on the 26th of last October, which does not demand insertion in the "list," but would still not be justifiable to leave unmentioned. A collier boy coming from his work chose to get behind the buffer of a locomotive, in order to have a ride home; shortly after that the engine unfortunately came in contact with some railway trucks, and the boy's thigh was broken in pieces. He underwent amputation, but died almost immediately afterwards. The engine-driver should have been punished for allowing the poor child to encounter such dreadful danger; he must have known that he was highly culpable in permitting it.

Having now described all the occurrences *in coal*, I at once proceed to the details of the ironstone mines of the district, but I am unable to give quite so good an account of them as usual.

In pursuing their calling in these extensive establishments 16 persons lost their lives in 1868, whilst during the previous year the record was only 14; and yet there was but little, if any, increase in the production of that valuable mineral in the year now under notice. Of the above number, 13 met with death through the great prevailing cause of accident, "falls of roof and mine." The other three were killed by "miscellaneous causes" underground.

Then there were 20 non-fatal accidents in ironstone mines, whereby 22 persons were more or less injured.

The condensed return of all the district, and all its mines, both those of coal and of ironstone, will, for 1868, then be as follows:—Separate fatal accidents in coal 59, deaths therefrom 61; non-fatal in coal 106, inflicting injury on 117; fatal accidents in ironstone, 16, consequent deaths 16; non-fatal in ironstone, 20, causing hurt to 22; casualty from which the "list" is free, one, bringing about one death. Total, 202 separate accidents affecting 217 persons, of whom 78 were deprived of life and 139 underwent burnings, fracture, contusion, and in many cases amputation and other surgical operations.

No boiler explosion has been reported to me from any one of the five counties of my district, and it cannot be considered otherwise than remarkable, that, though it is more than 10 years since I was removed from Staffordshire to take charge of this south-western division of mines, but one life has been lost by boiler explosion on either side of the estuary in all that very long lapse of time.

I have now to make mention of an occurrence that certainly is of more importance than any other legal event in all the annals of inspection from the very first Act of Parliament even down to the present time now close upon 20 years.

On the 16th of June 1865, the gas fired in the new Bedwelty pits belonging to the Tredegar Iron Company, and both accident and results were of so grave and serious a character, that at the inquest the jury returned a verdict of manslaughter against the viewer; but at the Monmouth assizes the grand jury did not find a true bill. I was then ordered to prosecute the owners of the colliery for infringement of the Act of Parliament, and I lost no time in initiating the proceedings. After very many delays and protracted sittings, the magistrates decided against me, and my solicitors then applied for a case to be submitted to the Court of Queen's Bench, which was accordingly granted. All these details were at the proper time regularly and minutely reported to the Home Office, and, suffice it now to say, that in June 1868, the Justices of the Court of Queen's

Bench decided in manner as I now quote from the printed "Weekly Reporter" of that particular period.

"Q. B. June 4.

Brough, Appellant, v. Homfray and others, Respondents.

23 & 24 Vict. c. 151. s. 10.—Rules 1 & 2.—Colliery Ventilation.

Rule 1, under section 10 of the above Act, requires that an adequate amount of ventilation shall be constantly produced in all Coal Mines or Collieries and Ironstone Mines to dilute and render harmless noxious gases to such an extent that the working places of the pits, levels, and workings of every such colliery and mine, and the travelling roads to and from such working places, shall, under ordinary circumstances, be in a fit state for working and passing therein, &c. An information under this rule having been dismissed, and a case stated thereon,—

The Court, though sending back the case to be re-stated, intimated a strong opinion that not only the working places and roads in a colliery should be kept ventilated under this rule, but that so much of the colliery must be kept ventilated as will secure that the roads and working places shall not become inundated with foul air from other parts of the mine.

This was a case stated by Justices under 20 & 21 Vict. c. 43. on an information which they dismissed, and which was brought before them under the sections 10 and 22 of 23 & 24 Vict. c. 151. It charged that the Respondents, being the owners of a colliery, had not caused, in accordance with Rule 1, an adequate amount of ventilation to be constantly produced in such colliery to dilute and render harmless noxious gases to such an extent that the working places of the pits, levels, and workings of such colliery, and the travelling roads to and from such working places, shall, under ordinary circumstances, be in a fit state for working and passing therein.

It appeared that in the mine of which the Defendants were proprietors an explosion occurred causing the loss of several lives. It appears to have occurred in consequence of the accidental opening of a door by which a disused chamber, in which it appeared that gas had accumulated, had been shut off from the rest of the mine. This chamber or cavity had been properly fenced in accordance with Rule 2, which provides that places in which gas is suspected to have accumulated shall be kept properly fenced off. The men were killed at one of the working places, but in consequence of the escape of the gas from the disused chamber.

Manisty, Q.C. (*Matthews, Q.C.* with him), for the Appellant.—The owners of collieries are bound by the 10th section to keep the working places ventilated; and if, for this purpose, it is necessary to keep adjacent parts of the mine ventilated, they are bound to do so. In fact the obligation on them is to keep the mine ventilated so as to secure the safety of the workmen.

H. James, for Respondents, called attention to the second rule, which enjoins that places in which gas is suspected to have accumulated shall be kept properly fenced off. If the respondents were guilty of any offence it was under this rule for inefficient fencing. (Cockburn, C.J.—I understand the men were killed in the working places.) Yes, but in consequence of the escape of gas from a disused chamber through a door which had been opened by a boy. There is no information for inefficient fencing off, and indeed there is ample evidence that it was properly fenced off, and no accident would have occurred but for the opening of the door. (Cockburn, C.J.—That will not dispense with the necessity of ventilating or keeping ventilated the rest of the colliery.) There is no evidence that there was a want of ventilation where the accident occurred. (Cockburn, C.J.—You must do two things,—firstly, ventilate the working places; secondly, properly fence suspected places so as effectually to prevent persons entering the dangerous places. If, instead of ventilating a disused place, you shut it off, and some one afterwards opens the door of it, when gas has accumulated in it, and it escapes and causes an explosion, you are liable for not keeping it ventilated.) Where mines extend over miles, many disused chambers exist which it is impossible to keep ventilated. (Blackburn, J.—Where it is impossible to ventilate, or where cavities exist, then it is your duty to prevent the escape of gas by an air-tight wall.)

It was intimated by the Court after the argument that the case ought to be sent back to be restated, as the facts were not sufficiently brought before it to enable it to pronounce a final decision. So far, however, as the case went, the following opinions were delivered:

Cockburn, C.J.—We are agreed that the working place has not been kept ventilated. The provision of the statute is to the effect that the whole mine must be kept ventilated so as to prevent the working places becoming dangerous by reason of gas accumulating in them. You must ventilate so much of it as that it will be safe for the working people. But the contention for the Defendants is that the accident was owing not to insufficient or imperfect ventilation, but to the act of a boy in opening a door which ought not to have been opened. However, this does not get over the difficulty that, as a fact, the mine was not kept sufficiently ventilated so as to secure the safety of the workpeople.

Blackburn, J.—I concur in the interpretation of the rule as laid down by my Lord. (Reads the two rules). The meaning is, that you shall ventilate the mine to such an extent that there will be no danger to the working places.

Mellor, J., concurred.

Lush, J.—I concur with the rest of the Court. I believe it is admitted that the place where the explosion occurred was, except so far as it was affected by the escape from the disused chamber, kept sufficiently ventilated.

Case remitted to be restated.

Attorneys for the Appellant, *Sharp & Ullithorne.*
Attorney for the Respondents, *T. Clark.*"

The whole of the above quoted case, with its elaborate matter and argument, I have copied, *verbatim et literatim,* from the "Weekly Reporter" of Saturday the 15th of August 1868.

I have to say in addition, that even after all this, it was still some considerable time before the same Justices of the Peace for the county of Monmouth were enabled to sit for a re-hearing in the town of Tredegar. But, however, finally, at the very long interval of three years and five months from the date of the explosion, the case—that of disobedience of the First General Rule of the Act of Parliament 23 & 24 Victoria, c. 151.—was again gone into, and a conviction was recorded in my favour, accompanied by the infliction on the Defendants of the mitigated fine of five pounds and costs; and, still later on, the Judges of the Court of Queen's Bench made an order that the said Defendants should likewise pay the costs of the special case.

The last observation I have to make on this exceedingly protracted litigation is, that it has been the means of bringing about so admirable an interpretation of that particular portion of the Act of Parliament, that I believe, if due consideration be but given to it, the ruling of the Justices of the Court of Queen's Bench will be equal in useful effect, as far as explosions of fire-damp are concerned, to the appointment of an increase to the present staff of Inspectors. When the law is thus clearly laid down, our arduous duty is rendered lighter and easier, and more abundant satisfaction will be given both to the Government of the nation, and to the public at large. It may not be inopportune here for me to beg permission to repeat the recommendation I made before the "Select Committee on Mines" some time ago, that, for the better administration of the Mining Acts of Parliament, the appointment of Stipendiary Magistrates in crowded districts would greatly tend to simplification, and would obtain the highest possible approval from all who are concerned in the greatest of all branches of British industry—that of mining for coal and for ironstone.

Of late the employment of scientific apparatus underground has attracted increased attention; though, as I have stated in previous annual reports, the idea is by no means new, on the contrary, such instruments have long been used, and for the most part their value in colliery operations has met with the most thorough appreciation. More especially has the oscillation of barometrical pressure, and the varying differences in temperature, been closely watched and studied by mining engineers, and valuable facts from time to time have been arrived at and collated. I have of late observed that at a longer or shorter period after the autumnal equinox, explosions of fire-damp occur in groups. Those disasters manifested themselves in a remarkable degree in 1866 and in 1867; and, when 1868 came round, its closing months were accompanied by continued storm, and in some places by earthquake, and, as in the two previous years, fearful explosions of carburetted hydrogen ensued. It is possible that hurricanes may have something more to do with the interruption of the ventilation of our pits than we are aware of; and moreover it is not irrational to suppose that geognostic phenomena may also affect our mines in some manner or other as yet entirely unknown to us.

Happily we know a little about the atmosphere that surrounds the globe, not only of its chemical composition, but also of its physical status. We know that it is liable to considerable variations in its density, from its maximum weight down even to comparative tenuity; and this natural alteration of specific gravity proves to be a most serious matter in carrying on safe and healthy ventilation. Such remarkable change in the air is faithfully represented on the barometrical scale, ranging from as high as 30·60 inches in our latitudes, down even as low as 28·60 inches. Then again, the variation in temperature is most important, in fact thermometrical difference is the very source and essence of all furnace ventilation. It would then be supposed that persons engaged in colliery pursuits would very naturally be interested in those two important facts. But, at intervals (I am happy to say sufficiently rare), there are still met with those who have but little consideration for the simple instruments that record and indicate the above two important meteorological occurrences. No doubt this disregard of first principles had, to a certain extent, been observed by the late eminent Mr. Nicholas Wood, and was possibly one of the reasons why he so strongly urged that viewers should receive a higher order of education in connection with the Durham University. Than Mr. Wood, no one more highly appreciated the value of scientific instruction for those who wished to dedicate themselves to the important occupation of coal mining.

It is not mere familiarity with common instruments that constitutes scientific acquirement; the use of barometer, thermometer, anemometer, water-gauge, theodolite, circumferentor, and spirit level, is easily learned. But mining engineers should go far beyond that; the knowledge, to a very considerable extent, of geometry and mathematics, chemistry, physics, mechanics, geology, and mineralogy, is absolutely necessary.

With regard to the instruments already spoken of, I beg permission to say, that we do not at present know but that others may be required in mining. It is possible that the time may arrive when we may even come to the use of the seismometer underground, for earthquake is not altogether unknown in England. Or sound practical chemistry may some day be of advantage to us, for instance, tests for the detection of allotropic oxygen or ozone in coal mines. Though we are not all of us acquainted with delicate and intricate instruments and other philosophical apparatus, we are not therefore justified in proclaiming that they are positively valueless in colliery operations. There are properties in air of which we are even now in a state of ignorance, but which in time may still become known to us in such a manner as to suggest entirely new ideas. That remarkable periodicity of explosion of fire-damp which I have already pointed out as occurring in certain months of the year may hereafter become perfectly comprehensible to us, and other useful discoveries may be made by continued philosophical research.

The late lamented physicist and chemist Faraday, when pursuing his investigations on the magnetism of the constituents of the atmosphere, found that "oxygen in various "media was strongly attracted by the magnet; in coal gas, for example, it was power- "fully magnetic, whereas nitrogen was diamagnetic." At one period the question actually occurred to him whether or not he might be able to separate the oxygen of the atmosphere from its nitrogen by magnetic analysis. It is from great names like Faraday's that we must look for light and discovery; already much has been accomplished for and by science; and coal mining as well as other branches of industry will be sure in time to reap the benefit of all such research. In the meanwhile, that which we as practical men have to do, is to sweep the working places of our fiery collieries with abundant supplies of fresh vital air—there lies the maximum means of safety after all; if the air does not get to the back of the work, it is not worth while to go to the expense of producing it. Plenty of splits must be insisted on, rigid discipline should be established throughout the mine, and, as a last recommendation and repetition, we should never neglect the free use of the philosophical instruments that just at the moment belong to our extremely limited list or repertory.

The last subject on which I am required to speak is education amongst the mining classes; I have generally left it to the very close of the annual Report, simply because I have little to say on the matter. All that I can observe is, that schools seem to be found almost everywhere in the various districts, but I fail to recognize a corresponding improvement amongst the young people; at any rate I do not witness such progress as I earnestly wish to see,—and so, I suppose, education will remain in a suspended state, until means are adopted to render it compulsory.

I have, &c.
(Signed) Lionel Brough,
Inspector of Mines.

To the Right Hon. Henry Austin Bruce, M.P.,
Secretary of State for the Home Department,
&c. &c. &c.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS of LIFE arising therefrom, in the SOUTH-WESTERN DISTRICT, during the Year ending the 31st of December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868. Jan. 3	1	Mydylog -	Nantyglo -	J. and C. Bailey - -	George Nott -	Collier -	60	A "bell mould," as it is termed, fell from the roof and killed him. I satisfied myself by examination that it was altogether concealed from view, and that there was not a suspicion of it until it suddenly fell.	–	1	–	–	–
" 7	2	Aberbeeg -	Pont Aberbeeg -	Webb and Spittle -	Isaac Barwell -	Collier -	30	This also was the fall of a "bell mould," which detached itself from the roof without notice; it weighed about 12 cwt.	–	1	–	–	–
" "	3	No. 4 - -	Sirhowy - -	Ebbw Vale Co., Limited -	Henry White -	Collier -	48	A portion of the roof fell as he was endeavouring to get down some coal a little in advance. This poor man had carried on his stall in a most workmanlike manner.	–	1	–	–	–
" 9	4	Dean Lane -	Bedminster -	Henry Bennett - -	John Towzer -	Collier -	31	The roof fell on him, but he could have got it down in safety if he had but kept under the timber.	–	1	–	–	–
" 10	5	Bwlchygarn -	Beaufort -	J. and C. Bailey - -	Edward James -	Collier -	18	Killed instantaneously by a fall of "rashings," which, just there, came in under the true roof of the "elled" vein of coal. He should have kept those "rashings" cropped close to the face of work.	–	1	–	–	–
" 15	6	New Bowson -	Forest of Dean -	Great Western Deep Coal Company, Limited.	Ed. Hooper -	Sinker -	30	Drawn over the pulley; there was probably some blundering about signals in this case.	–	–	1	–	–
								Carried forward - -	–	5	1	–	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward - -	–	5	1	–	–
Jan. 24	7	Tylery Colliery	Abertylery -	John Jayne - -	Jas. Blacker -	Collier -	18	The Elled vein of coal carries a good top, but all about the immediate neighbourhood where this youth lost his life a dangerous shale has come in, full of slips and joints. Several props were up, but still, as it turned out, not in sufficient number. With such roofs as this the managers must really insist on timber being set up wherever there is room for it, leaving, of course, space sufficient for the workpeople to operate.	–	1	–	–	–
„ 27	8	Brandybottom Colliery.	Pucklechurch -	Jefferis and Co. - -	Thos. Woodington	Collier -	40	A heavy stone fell from roof just where a diagonal slant or joint passed through the stratification. Died the day after having been injured.	–	1	–	–	–
Feb. 4	9	Cwmsychan Colliery.	Abersychan -	Ebbw Vale Co., Limited -	Daniel Evans -	Collier -	56	The stone that killed him fell from the roof of the "three quarter vein."	–	1	–	–	–
„ „	10	Foxesbridge Colliery.	Forest of Dean -	Barrett and Crawshay -	Hy. Fleetwood -	Collier -	14	Fell under a "cart," and was so severely injured that he died on the 16th.	–	–	–	1	–
„ 19	11	New Pit Colliery	Blaenavon -	Blaenavon Iron Company	Wm. Williams -	Road man -	25	A stone fell from roof whilst he was clearing a fall on the main level. The cause can only be attributed to two "slips" meeting together in a point or angle, and thus the mass was enabled to detach itself.	–	1	–	–	–
								Carried over - -	–	9	1	1	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
								Brought forward - -	–	9	1	1	–
1868. Feb. 19	12	Tunnel Pit Colliery.	Ebbw Vale -	Ebbw Vale Co., Limited -	William James -	Stoker, underground.	24	The terrific gale on the mountain on that day suspended the ventilation for a short time, in consequence of their being scarcely any stack on the upcast shaft; then the products of combustion of the underground boiler fire backed and overpowered him.	–	–	–	1	–
„ 21	13	Tyr Phil Colliery	Rhymney -	Rhymney Iron Company -	John Jones -	Collier -	22	Hurt in the head by a fall of shale, and was so injured that he died on the 22d.	–	1	–	–	–
„ 22	14	Millfraenhill Colliery.	Brynmawr -	John Jayne - -	Samuel Perrott -	Collier -	58	The roof fell and killed him; he was requested just before to put up a prop, but refused, saying that he was satisfied that the place was safe.	–	1	–	–	–
„ 26	15	MardyPitColliery	Rhymney -	Rhymney Iron Company -	John Jones -	Collier -	18	Fall, whilst drawing away some coal at the bottom of a "slip."	–	1	–	–	–
Mar. 13	16	No. 15 Pit Colliery.	Ebbw Vale -	Ebbw Vale Co., Limited -	Wm. Davis -	Collier -	37	Injured on the 13th of the month by a fall of coal and clod in the face of his stall, and died on the 15th.	–	1	–	–	–
„ 21	17	Blaendare Colliery.	Pontypool -	Blaendare Co., Limited -	Thos. Short -	Collier -	30	Coal suddenly fell and killed him on the spot.	–	1	–	–	–
„ 23	18	Glyn Pit Colliery	Pontypool -	Ebbw Vale Co., Limited -	Jno. Watkins -	Haulier -	22	Fall of rubbish from the roof - -	–	1	–	–	–
„ „	19	Terrace Pit Colliery.	Rhymney -	Rhymney Iron Company -	Danl. McArthy -	Collier -	40	Whilst he was ramming the safety fuse the shot went off. It is supposed that he had in a blundering manner placed his light close to the shot hole, and so fired the fuse.	–	–	–	1	–
„ 24	20	Old Coal Pit -	Blaenavon -	Blaenavon Iron Co. -	Dd. Jenkins -	Collier -	25	A piece of clod from roof suddenly fell and killed him. The face of his work should have been "cropped."	–	1	–	–	–
								Carried over - -	–	16	1	3	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward - -	–	16	1	3	–
April 3	21	Mells Colliery -	Frome - -	Stephen Steeds and Co. -	John Cary - -	Hitcher -	18	Hurt by cage commencing to descend instead of going up, whereby he was caught before he was well in. This happened, no doubt, in consequence of the onsetter at the extreme bottom having misunderstood the signals. The injured man died on the 13th.	–	–	1	–	–
„ 4	22	Glyn Pit Colliery	Pontypool -	Ebbw Vale Co., Limited -	Wm. Marshall -	Collier -	57	Killed in the rock vein coal whilst he was actually sounding the place to ascertain if it was safe or otherwise. The stone that fell was liberated from the top by its slanting structural division. A moment before his death he told his son that he considered the place safe.	–	1	–	–	–
„ 15	23	Cwmbran Colliery	Newport -	John Lawrence - -	Thos. Williams -	Door Boy -	11	Fall of roof in main road; but he had no right whatever to leave his door. I entirely disagree with the trappers going with the hauliers. A grime and a "slip" let the mass fall easily down, and, moreover, the place was all of a "squeeze," and the bottom "pucking."	–	1	–	–	–
„ 21	24	Twerton Colliery	Bath - -	F. & D. Brown - -	Jno. Clark -	Collier -	25	Killed by the flat wire rope breaking, and falling on Clark and another who were working in the bottom of the shaft under a weak scaffold.	–	–	1	–	–
May 4	25	Forge Pit Colliery	Nantyglo - -	J. & C. Bailey - -	Wm. White -	Collier -	40	Killed by heavy fall of roof - -	–	1	–	–	–
„ 8	26	No. 8 Pit Colliery	Ebbw Vale -	Ebbw Vale Co., Limited -	Wm. Brimble -	Collier -	16	Fall of top coal whilst filling a tram in the heading which he and his father were driving. After the coal fell an unseen "slip" became evident enough.	–	1	–	–	–
								Carried over - -	–	20	3	3	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost. Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward - -	–	20	3	3	–
May 29	27	No. 9 Pit Colliery	Ebbw Vale -	Ebbw Vale Co., Limited -	Thos. Ashman -	Collier -	21	Fall of "bell mould," by which he was so severely injured that he died the next day.	–	1	–	–	–
June 6	28	Black Vein Colliery.	Risca - -	T. W. Rhodes - -	Hy. Kingston -	Collier -	43	Killed on the slope in consequence of fracture of draw-plate. There were plenty of safety stalls, but nevertheless he got overwhelmed by the rushing trams. He had that moment passed a safety hole, but no doubt his presence of mind was gone.	–	–	–	1	–
July 7	29	Deep Pit Colliery	Nantyglo -	J. & C. Bailey - -	Isaac Rees -	Collier -	50	Fall of coal caused by a "slip" -	–	1	–	–	–
„ 8	30	No. 2 Pit Colliery	Sirhowy -	Ebbw Vale Co., Limited -	Chas. Lloyd -	Haulier -	16	Whilst taking coal from the top of the pit he fell under a loaded tram.	–	–	–	–	1
„ 11	31	Trafalgar Colliery	Forest of Dean -	C. Brain and Sons -	Jas. Collins -	Collier -	15	He concealed some gunpowder, and it ignited in his pocket, burning him so severely that he died the next day.	–	–	–	1	–
„ 14	32	Paulton Engine Colliery.	Paulton -	William Evans and Co. -	Wm. Swift -	Collier -	29	Killed by overwinding, in consequence of the "load indicator" getting unobservedly deranged. He found he was going too high, and jumped out of the cage, and fell right down the shaft.	–	–	1	–	–
July 29	33	South Wales Colliery.	Cwm Tylery -	South Wales Colliery Co., Limited.	Rd. Jones - Jno. Williams -	Roadman - Haulier -	34 21	These men were employed to get down some top in a squeezed old road, and unfortunately they placed a tram on each side of them, so that in case of danger there was no escape whatever because of the narrowness of the road, then came the fall of roof. If there had been but one tram they could have escaped easily.	–	2	–	–	–
								Carried over - -	–	24	4	5	1

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward	–	24	4	5	1
Aug. 8	34	Tyr Phil Colliery	Rhymney	Rhymney Iron Company	Thos. Edmund	Collier	44	Fall of roof in stall, occasioned by a clayey joint or slant.	–	1	–	–	–
,, ,,	35	Howbeach Colliery.	Forest of Dean	Blakeney Co., Limited	Wm. James	Collier	26	Fall of stone from roof	–	1	–	–	–
,, ,,	36	Patch (open work)	Tredegar	Tredegar Iron Company	Wm. Newman	Collier	40	Fall of coal from face of open work	–	1	–	–	–
,, 11	37	Cinderpit Colliery.	Beaufort	J. & C. Bailey	Rd. Davis	Collier	68	Fall of roof at mouth of stall; he was striking the stone with a sledge, but in doing so he unfortunately disturbed a prop, and that caused the roof to fall.	–	1	–	–	–
,, 25	38	Deri Newydd Colliery, Cwm Bargoed.	Merthyr Tydfil	Jones and Co.	Lewis Morgan	Collier	21	Fall of roof, occasioned by a "smooth slip."	–	1	–	–	–
,, 31	39	Old Vobster Colliery.	Bath	Stephen Steeds and Co.	Mark Button	Collier	30	Explosion of fire-damp. Three other persons were burned with him, but he alone succumbed; he died on the 13th of September.	1	–	–	–	–
Sept. 17	40	No. 22 Pit Colliery.	Ebbw Vale	Ebbw Vale Co., Limited	Jno. Pritchard	Collier	63	Fall of roof over Elled coal	–	1	–	–	–
,, ,,	41	Upper Writhlington.	Radstock	Writhlington and Huish Company.	Chas. Whittock	Collier	41	Fall of bell-mould shaped mass of roof	–	1	–	–	–
,, ,,	42	Duck Pit Colliery	Forest of Dean	Goold and Company	Geo. Dobbs	Collier	40	Fall of piece of top on to the collar of a pair of timbers, and this wooden bar or collar struck him dead. There ought to have been plenty of "lagging" above the timbering.	–	1	–	–	–
Sept. 22	43	No. 8 Pit Colliery	Tredegar	Tredegar Iron Company	Wm. Biggs	Collier	56	Sudden fall of about three tons of coal whilst he was sitting down eating his dinner. A "slip" ran right up through the coal and top.	–	1	–	–	–
								Carried over	1	33	4	5	1

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward	1	33	4	5	1
Oct. 16	44	No. 9 Pit Colliery	Ebbw Vale	Ebbw Vale Company, Limited.	Hy. Mitchell	Collier	20	Fall of "bell mould" from roof	–	1	–	–	–
" 19	45	Patch (*openwork*)	Tredegar	Tredegar Iron Company	Thos. Rowe	Collier	50	Fall of "overlie" in a coal and mine patch. The stuff that fell should have been "terraced" down from above, and not "undergone" at the bottom, as unfortunately it was really performed.	–	1	–	–	–
" 22	46	Bryngwyn	Bedwas	W. S. Cartwright	David Jones	Roadman	40	Overwhelmed by water tank on the winning slope. Being the person appointed to look after the slope, and well knowing all its modes of action, he certainly should have exercised greater discretion by stepping aside at the right moment.	–	–	–	1	–
" "	47	Llwynypwll	Abergavenny	Hafod Colliery Company	Jno. Williams	Collier	65	Fall of roof over coal	–	1	–	–	–
" 24	48	New Bedwellty	Tredegar	Tredegar Iron Company	Jno. David	Collier	35	Fall of stone from top close by the side of the gob; it broke right over a timber prop. Died on the 7th December.	–	1	–	–	–
Nov. 12	49	No. 4 Pit Colliery	Sirhowy	Ebbw Vale Company, Limited.	Wm. Bevan	Helper	12	Trams crushed him to death as he was unhitching at top of slope. Too young for this sort of employment.	–	–	–	1	–
" 13	50	New Bedwellty	Tredegar	Tredegar Iron Co.	Jno. Hogan	Collier	36	Fall of "clod" between two coals; he should have spragged the "holing."	–	1	–	–	–
" 16	51	No. 6 Pit Colliery	Victoria	Ebbw Vale Company, Limited.	Jas. Blakemore	Collier	20	Fall of stone which dropped from between two "slips."	–	1	–	–	–
" 19	52	Tunnel Pit Colliery.	Ebbw Vale	Ebbw Vale Company, Limited.	Thos. Perkins	Collier	24	Fall of "big vein" coal in face of stall	–	1	–	–	–
" 23	53	Nelson Colliery	Forest of Dean	Osmon Barrett	Aaron Harris	Collier	33	Fall of a portion of the roof partaking of the nature of a "bell mould."	–	1	–	–	–
								Carried over	1	41	4	7	1

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.				
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward - -	1	41	4	7	1
Nov. 26	54	Rock Vein Colliery.	Risca - -	T. W. Rhodes - -	Ed. Holmes -	Collier -	30	Fall of coal in consequence of his not putting in a punch prop.	–	1	–	–	–
" 27	55	Clandown Colliery	Radstock -	Clandown Coal Company	Wm. Carter - Dd. Millard -	Collier - Collier -	30 20	Gunpowder explosion, by which they were so severely injured that W. Carter died on the 10th of December and D. Millard on the 14th. They were not justified in using the powder in coal; it was supplied to them to blast top with.	–	–	–	2	–
" 30	56	Aberbeeg Colliery	Pont Aberbeeg -	Webb and Spittle -	Thomas Gibbs -	Door-boy -	12	Injured by trams on the 30th, and died on the 5th December.	–	–	–	1	–
Dec. 2	57	Black Vein Colliery.	Risca - -	T. W. Rhodes - -	Ed. Beddow -	Roadman -	26	A defective roller threw the set of trams off the rails, and crushed him so dreadfully that he died next day.	–	–	–	1	–
" 10	58	Lightmoor Colliery.	Forest of Dean -	Henry Crawshay - -	Moses Chivers -	Fettler -	35	Killed by falling down the shaft from the rocky vein to the bottom, whilst clearing the plunger of mud. The stage on which he stood was small and insufficiently protected.	–	–	1	–	–
" 15	59	Ty Trist Colliery	Tredegar -	Tredegar Iron Company -	Morgan Thomas -	Collier -	62	Fall of "engine coal" in his working place, whereby he was so injured that he died on the 22nd.	–	1	–	–	–
								Total - - -	1	43	5	11	1

List of Fatal Colliery Accidents—*continued.*

RECAPITULATION.

Total number of separate fatal accidents reported in coal mines in the year 1868	- 59
Total number of persons killed by those 59 separate accidents - - -	- 61

Whereof	1	death was occasioned by explosion of fire-damp.
„	43	deaths were brought about by falls of coal and stone.
„	5	„ took place in pit shafts.
„	11	„ arose from miscellaneous causes underground.
„	1	death happened on the surface.
Total	- 61	deaths, as enumerated and described in the List.

COMPARATIVE TABLE OF THE LAST FOUR YEARS.

In 1865,	26	persons lost their lives by explosion of fire-damp; whilst, during the whole of the same year, the total number of deaths from all causes amounted to - - - - -	- 82
„ 1866,	6	„ „ „ „ „	- 81
„ 1867,	6	„ „ „ „ „	- 71
„ 1868,	1	„ „ „ „ „	- 61

NON-FATAL ACCIDENTS IN COAL MINES REPORTED THROUGHOUT THE YEAR 1868.

Of these in all 106, attended with injury more or less to the persons employed, occurred in the various mining establishments of the district in manner as tabulated below :—

7	accidents	by fire-damp,	whereby	25	men and boys	were burned by explosion, or underwent contusion or fracture by its expansive force.
55	„	by falls of stone and coal,	„	56	„	suffered wounds, broken bones, or bruises.
5	„	in pit shafts,	„	5	„	met with serious bodily injury.
23	„	from miscellaneous causes,	„	24	„	had bones fractured, or otherwise became incapacitated for a time.
6	„	occurred on surface,	„	7	„	received injury in some way or other.
106	accidents,			117	persons more or less wounded or hurt.	

Some of the above are already restored to health and employment; some are still suffering; and others, perhaps, may not be able to pursue their avocations for the remainder of their lives.

LIONEL BROUGH,
Inspector of the District Collieries.

LIST of the FATAL IRONSTONE MINE ACCIDENTS, and LOSS of LIFE arising therefrom, in the SOUTH-WESTERN DISTRICT of GREAT BRITAIN, during the Year ended the 31st Day of December 1868.

Date.	No. of Accidents.	Name of Mine.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost. Explosions.	Falls of Roof and Ground.	In Shafts.	Miscellaneous.	Above ground.
1868. Jan. 15	1	Gellynawsaidd -	Abersychan -	Ebbw Vale Co., Limited -	Jacob Jones -	Miner -	21	Fall of working ground on his head, crushing it into the floor of the mine.	–	1	–	–	–
Feb. 3	2	No. 5 Pit Mine Works.	Victoria -	Ebbw Vale Co., Limited -	Griffith Morris -	Miner -	68	Fall of clod in the face of his work -	–	1	–	–	–
Mar. 19	3	No. 6 Pit Mine Works.	Victoria -	Ebbw Vale Co., Limited -	Job Ralph -	Miner -	45	Fall of mine (a ball) lying over coal -	–	1	–	–	–
„ 26	4	Blackpin Mine Level.	Varteg - -	Partridge and Jones -	Joseph Harris -	Miner -	12	Fall of stuff overhead in consequence of a "slant" running up to a large ball of mine.	–	1	–	–	–
Apr. 1	5	Spotted Vein Mine.	Victoria -	Ebbw Vale Co., Limited -	Hy. Habakkuk -	Miner -	67	Injured by fall of mine ground whilst holing on the 1st of the month, and died on the 4th. An unexpected "slip" brought the stuff down.	–	1	–	–	–
May 2	6	Garn Slope Mine Works.	Blaenavon -	Blaenavon Iron Co. -	Ed. Hall - -	Hitcher -	25	He slipped and fell on the slope whilst the engine was in motion, and the rope carried him into contact with the drum. He died on the 8th.	–	–	–	1	–
„ 6	7	Red Vein Mine Works.	Victoria -	Ebbw Vale Co., Limited -	Rd. Moxley -	Miner -	19	He was drawing the top vein down, and that brought with it a portion of roof.	–	1	–	–	–
„ „	8	Mine Pit - -	Varteg - -	Partridge and Jones -	Ed. Redman -	Haulier -	13	Whilst driving the horse and loaded tram up a "dip heading," he either fell under or was riding in front with his feet so near the ground as to be drawn in under the loaded tram; however, nobody was near him at the time, and the exact mode of his death remains unknown.	–	–	–	1	–
June 22	9	Coity Pit Mine Works.	Blaenavon -	Blaenavon Iron Co. -	Thos. Watts -	Miner -	52	Crush of tram in consequence of not "spragging" it as he was taking it down the slope. He was so injured that he died on the 29th.	–	–	–	1	–
								Carried forward - -	–	6	–	3	–

List of Fatal Ironstone Mine Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.				
									Explosions.	Falls of Roof and Ground.	In Shafts.	Miscellaneous.	Above ground.
1868.								Brought forward - -	–	6	–	3	–
Aug. 4	10	Greenland Pit Mine Works.	Abersychan -	Ebbw Vale Co., Limited -	Charles Jones -	Miner -	40	Whilst ripping top he stepped back to avoid a fall of stuff, but unfortunately stumbled and fractured his skull; he died on the 6th of the month.	–	1	–	–	–
„ 12	11	Gantre Pit Mine Works.	Ebbw Vale -	Ebbw Vale Co., Limited -	Hy. Phillips -	Miner -	25	Fall of ground in the face of his working place.	–	1	–	–	–
Sept. 23	12	Engine Pit Mine Works.	Sirhowy - -	Ebbw Vale Co., Limited -	Jno. Price -	Miner -	31	Fall of ground in "long wall" working; the ground was "sconged" by the coal having been worked below.	–	1	–	–	–
Oct. 15	13	Patch (open Mine Work).	Tredegar - -	Tredegar Iron Co. -	Gwenllian Stagg -	Filler -	45	Fall of mine ground as she was filling a tram. There was a "slip" running right up through the stratification, and the ground should have been stoped down from above. I object to women undertaking such employment, as they cannot jump back as men can; it was the cause of her death in fact; female clothing is not adapted to such work.	–	1	–	–	–
Nov. 10	14	Black Pin Mine Level.	Ebbw Vale -	Ebbw Vale Co., Limited -	James Jones -	Contractor	60	Fall of roof in consequence of the trams getting off the plates, thus displacing timber, which brought the roof down. He was driving at the time.	–	1	–	–	–
„ 21	15	No. 3 Pit Mine Works.	Beaufort -	J. and C. Bailey - -	Jno. Swift - -	Miner -	30	Fall of stuff whilst working in a red vein stall. The ground was reticulated with "slips" and "slants."	–	1	–	–	–
Dec. 18	16	Mine Pit - -	Varteg - -	Partridge and Jones -	Caleb Carter -	Miner -	23	Whilst filling a tram with rubbish in the horse road near the face of his stall, the roof fell, and so injured him that he died on the 21st after undergoing amputation.	–	1	–	–	–
								Totals - - -	–	13	–	3	–

List of Fatal Accidents in Ironstone Mines—*continued.*

RECAPITULATION.

Total number of separate accidents in ironstone mines reported in the year 1868 - 16
Total number of persons killed by those 16 separate reported accidents - - 16

Whereof 13 deaths were occasioned by falls of stone and iron mine.
„ 3 arose from miscellaneous causes underground.
16 deaths, as enumerated and described in the List.

COMPARATIVE VIEW OF THE LAST FOUR YEARS.

In 1865, the total number killed in all the ironstone mines of the district, arising from every cause, amounted to - - - - - - 14
„ 1866, „ „ „ „ „ - 14
„ 1867, „ „ „ „ „ - 14
„ 1868, „ „ „ „ „ - 16

LIST OF THE NON-FATAL ACCIDENTS IN IRONSTONE MINES REPORTED IN THE YEAR 1868.

4	accidents occasioned by explosion of fire-damp,	whereby	5	persons were burned and bruised.
7	„ by falls of material,	„	7	persons were injured.
9	„ occurred from miscellaneous causes underground,	„	10	persons were severely hurt.
20	accidents.		22	persons injured.

These men and boys are for the most part progressing towards recovery ; but, as in coal works, should any death take place, such will be found in the next year's returns.

LIONEL BROUGH,
Inspector of the District Ironstone Mines.

Mr. Baker's Report.

REPORT on the INSPECTION of MINES in the SOUTH STAFFORDSHIRE AND WORCESTERSHIRE DISTRICT, for the Year ended the 31st December 1868.—By JAMES P. BAKER, Esq.

SIR, Wolverhampton, February 27th, 1869.

I HAVE once more the honour to transmit my annual Report as Inspector of Mines in the South Staffordshire and Worcestershire division.

The accompanying "list" exhibits 90 separate fatal accidents and 104 deaths, brought about in working the coal mines of this district during the year 1868, which, as will be seen from the statement given below, shows a slight decrease both in the number of fatal accidents and in the deaths resulting therefrom as compared with 1867, and also in comparison with the annual average loss of life for the seven years previous.

Total number of separate fatal accidents in the year 1867 - -	95
Total number of deaths by those 95 separate accidents - - -	111
Total annual average loss of life for the 7 years ending 1867 inclusive -	112·7

Comparative death rate.

Average of the last eight years.

This statement shows no very remarkable decline in the annual average death rate of the last few years. Nevertheless, it is always a pleasing duty for an inspector of mines to be able to report a diminution in the rate of mining mortality, however small, and it cannot be less satisfactory to the operative miners themselves and the community at large. Speaking of this district alone there is much to be thankful for, seeing that the annual average death rate of the last eight years has been about 50 less than the annual average from 1850 to 1860 inclusive. It stood at nearly 200 per annum, at a time when there were fewer colliers by thousands employed, and hundreds of thousands if not millions of tons of coal less raised. Gratifying however as these results really are, there is still much room for improvement both above and in the underground management of our collieries, especially where the charter-master system prevails, to which I called attention both in my last and in former reports.

To further diminish colliery accidents in this district we want, in many instances, a more vigilant and competent supervision both above and below ground, not only at every colliery, but in every pit.

Complete immunity from fatal accidents must not be looked for nor expected.

Nobody will pretend to say that if this were efficiently carried out it would entirely prevent accident, nor, in my opinion, would complete immunity from mining fatalities be achieved if an inspector were appointed to every pit in the kingdom, for dangers seen and unseen are always more or less present in the mines, against which no human skill and foresight can at all times provide. The necessity for better supervision, however, will be apparent when some of the most serious accidents of the year are brought under notice.

Quantity of coal raised.

During the year, owing to the depressed state of the iron trade of this country, the consumption of coal has been somewhat lessened, but the confidential returns of colliery proprietors and agents enable me to state that no fewer than 9,900,000 tons of 2240 lbs. have been raised, including as usual the colliers allowance coal, colliery consumption and waste, which I again estimate at 1,300,000 tons. This is still a large output. The depressed condition of the iron trade does not affect the collieries now to the extent it did formerly, owing to the great facilities afforded by railways for the transport of coal to different parts of the kingdom, and the quantity required for the varied and increasing commerce of the country.

In the interest of the teeming population of this district whose occupations depend upon the continued supply of coal it is to be desired that the mineral resources of this coal field should be economized as far as possible, especially that portion of it which is practically and commercially applicable to the manufacture of iron. Considering the quantity annually raised the coal seams now available are very much nearer exhaustion than the trade and some of the people of the district seem to be aware of, or are, at any rate, willing to admit.

This question was mooted by me several years ago, and I briefly alluded to it in my Report of last year, and the opinions I then ventured to offer have been fully confirmed by the inquiries I have made during the past year.

The produce of some of the larger collieries is mainly sold for domestic use, and at a price far beyond that generally given by the iron trade. With the exception of these, scarcely any owners or agents to whom I have spoken have named so long a period for the duration of their collieries at their present rate of working as I was myself disposed to assign, and as the small and inferior collieries die out the demand will of course be greater on those that may still remain, and thus the calculations as to time will be proportionally shortened.

I wish it to be distinctly borne in mind that my observations apply chiefly to the iron trade of the district, and that I do not allude again to this subject to cause unnecessary alarm, but simply to keep it before the mining public, so that no further opportunity may be lost, either in thought or action, with a view to ascertain what available resources exist on the opposite sides of the great western and eastern faults of this coal basin.

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It is to be regretted that excellent opportunities in our extreme east and west collieries at West Bromwich and Essington have already been allowed to slip by, where trials might have been commenced in the Permian Rocks at the respective depths of 400 and 200 yards. Such opportunities are rarely met with in this coal field, as depths from the surface, varying from four to six and probably eight hundred yards, might have been reached with suitable machinery, which would have gone far towards determining the question of the existence of coal in those localities.

Of the 104 fatalities which occurred during the past year, three were the result of explosions of fire-damp, 58 of falls of roof and coal, 21 of accidents in shafts, and 18 were owing to miscellaneous accidents underground, and four on the surface.

Fire-damp as usual stands first in the "list," and the number killed shows a very remarkable and satisfactory diminution, corresponding exactly with the number under this head in the year 1858.

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The first of these cases, No. 40 in the list, was the result of the deceased's own disobedience to orders and indifference to danger. He was engaged thirling a headway, and when he himself thought he was near putting through, he incautiously, after being advised to the contrary, went into the head into which he was expecting every minute to thirl with a naked candle and fired a small quantity of gas, which injured him so severely that he died in a few days after the occurrence.

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The other case, in which two persons were killed, No. 78, might have been attended with more serious consequences. Happily, however, the major part of the colliers were some distance away, and, with one or two exceptions, escaped both the blast and the after-damp, and got safe out of the mine.

One of the deceased men was the deputy manager underground, and had charge of the mine. On the morning in question he went with his lamp as usual to examine an opening or stall in which a quantity of coal had been thrown or got down by the miners overnight, and when he had arrived at the spot he called the other unfortunate man to bring him a "candle" and a "pick," but before he could reach him the explosion happened which nine days later terminated the existence of two fine and useful men.

On my examination of the pit after the accident I could not detect the presence of gas, and the ventilation was in every respect sufficient.

The fall of coal on the night before the accident had left a cavity in the roof of the stall which had been the working place of several miners up to within some two or three hours before the explosion, and which, nevertheless had, during the *interim*, filled with gas. This the deceased might have easily detected if he had understood its character, and the duties devolving upon a man placed in such a position. This case shows how the lives of the colliers are occasionally placed in the most imminent peril, and how they sometimes escape serious injury and violent death. As it was, all the men in the vicinity of the fire suffered more or less, but none except the two mentioned lost their lives.

At the inquest upon the bodies it was presumed from the evidence, and also the statements of the two men before death, that the deputy had neglected to examine the recently made cavity in the roof of the stall, and unscrewing the gauze of his lamp, exposed the flame, and hence the explosion, which is by no means improbable, unless the lamp, which by the way has not been found, was defective or injured during the examination. Of this, however, there was no evidence, and judging from the habits of many of our underground deputies, the former was in all likelihood the course pursued in this instance.

This view of the case affords an illustration of that want of competent supervision which I have already alluded to in this and former Reports, without which, and more thoughtful care on the part of the miners themselves, I regret to have to say, that any considerable diminution in the loss of life amongst the operatives of our collieries in this inspection district is, I fear, almost hopeless.

Falls of Coal and Roof.

The deaths from this cause are two less than they were in the year previous, when 60 were recorded. This accidental mortality, as it is too often termed, still runs high, and will doubtless remain so till our underground discipline shall be greatly improved, on which, however, having previously called special attention to the subject, it is not at all necessary for me to enlarge.

As there are, with few exceptions, no entries under this heading in the list of an unusual character, I do not consider it necessary to give a detailed account of each case, inasmuch as the list itself contains a brief explanation of the time, place, and cause of death. I shall therefore only refer to those cases which appear to require special remark.

Six lives lost which better discipline and more thoughtful care would in all probability hav prevented.

Of the 58 persons killed by falls of coal and roof, 6 were pikemen, who had neglected to sprag or spurn the coal whilst holing and cutting, or had improperly removed timber props.

While men of this class, who, more than any other operatives employed underground, have both the time and the means for protecting themselves, remain so indifferent to their own safety, accidents, more or less fatal, are inevitable.

The special rules go far enough to prevent such neglect if only they are strictly enforced.

The Hilly Colliery accident, No. 38 in the "list," is a case of such reckless colliery management as never before came under my notice during the whole course of my experience.

How the un derground workings a sometimes conducted, and the sa result arisi therefrom.

The owners, Messrs. Nock and Potter, were formerly charter-masters in the district, and were at the time of the accident working this colliery in the top part of the thick coal. On the morning of the sad occurrence the stall, which contained a fall of coal, was duly examined and pronounced unsafe, owing, as one of the witnesses stated at the inquest, to the "rock-roof stirring;" in consequence, the loaders were sent into another side of work. After loading five or six skips the deceased and two more were ordered back by the deputy to load the coal in the dangerous stall, when, after the lapse of about three hours, the rock-roof, which was found "stirring" only a short time before, suddenly fell, nearly severing the head of the deceased from his body, whilst the trunk was shockingly mutilated.

In this instance there was not, according to the witnesses at the inquest, a single stick of timber under the roof, nor any for use either in the pit or on the surface of the colliery; but, notwithstanding the evidence of one of the owners to the effect that the deputy's acts were improper, the jury returned a verdict of "accidental death."

Such a revelation of colliery management is a discredit to any mining district, and, I venture to think, goes far to confirm what both myself and predecessors have said and written on this subject.

The special rules were duly hung up at the colliery office, but had not been established in accordance with the Mines Inspection Act, consequently proceedings could not unfortunately be instituted for any violation of their provisions. Subsequently, however, and in compliance with the instructions of the then Secretary of State, proceedings were taken against one of the owners for neglecting to establish special rules in conformity with the provisions of the statute, and the case was eventually brought before the Oldbury bench, and the defendant fined 2*l.* and costs.

No. 63 occurred at the Rowley Hall Colliery. The charter-master, a worthy and excellent collier, on the morning in question descended the pit at an early hour, and in his over anxiety to start the "bond," decided to prop some coal which had been holed or under cut on the side of one of the gate-roads for the purpose of widening it. While he stood waiting for the timber to be brought, the coal suddenly fell upon him, inflicting injuries so severe that he died the same day at his own home, the sad result of too long delaying the timbering.

Falls of coal and roof frequently happen in thick coal mining, owing to a phenomenon technically called a "bump," caused by the subsidence of the superincumbent strata over large cavernous excavations of "pillar and stall" workings, which by the "long wall" system is by no means so frequently met with. About 25 per cent. of the deaths under this heading during the year are chiefly attributable to this cause, and so long as the pillar and stall mode of working continues deaths will, more or less, I fear, have to be annually recorded. It is, however, gratifying to learn that in several instances the "long wall system" is now about to be commenced, an example which, so far as it can be carried into effect, will it is to be hoped be followed by "thick coal" colliery owners generally, as it is too well known in this district to require comment that the "long wall" mode of working the thick seams has highly contributed to the general produce per acre of ground worked, and most important of all, to the safety to life and limb of those employed therein.

Shaft Accidents.

Cannock Chase Colliery accident.

These casualties are five in number more than they were in the year 1867, being an increase of about 25 per cent., due in a great measure to the accident which took place at one of the pits of the Cannock Chase Colliery on the 15th May last, and by which a larger number of persons were sacrificed than by any other single accident which happened in the district during the year. On the morning of the day on which the accident occurred, eight men and boys, the usual number allowed by the special rules, were descending the shaft when the "flat wire-rope" suddenly snapped, precipitating them to the bottom. Five were killed at the time, another, a youth of 16, died shortly after the accident, and two others recovered from the very serious injuries they sustained.

Inefficient supervision.

On examining the rope I found that at the point of fracture it had been covered for about 18 inches with hemp, which had become so hard and solid as to form a bolster on each side of the flat rope, about three quarters of an inch in thickness for two thirds of its length, tapering off towards the extremities. It appeared that the object of this very unusual application was, that the wrapping of hemp should act as a "token" to show the engineman when the skip was opposite a "headway or insett" where it had to stop. There was no indicator, which would have rendered any such rude and dangerous provision unnecessary. I found that only 25 or 26 wires, or about a *seventh* of the number composing the rope, were whole when the accident occurred. The hard and solid wrapping of hemp no doubt caused the wires to break, as in passing over the periphery of a five-foot pulley, and then under the drum which was of similar diameter, it bent the rope to and fro at different angles, gradually breaking the wires, until those remaining, which had themselves become weakened, suddenly snapped. Not only was this "token" the cause of the rope breaking, but it had the further effect of preventing the discovery of its gradual destruction. The special rules require the periodical examination of the ropes, but this was impossible unless the hemp, which had been on for three or four months, had first been removed. Mr. M'Ghie, the manager for the company, acknowledged at the inquest that it was improper to place tokens of this kind upon ropes, that they would have an injurious effect, and would prevent any effective examination; and he was of opinion that the fracture of the wires at the point of severance had been going on for three weeks or a month before the accident, and could have been discovered but for the wrapping of hemp.

Hargreaves Walters, the colliery engineer, was perfectly aware of the token having been put upon the rope by the engineman, but never supposed that it would injure the rope, and never had it removed for the purpose of examination.

Verdict of the jury.

The jury, after a long consultation, agreed to a verdict of "accidental death," but censured the engineman for putting on the token, and the manager, Mr. M'Ghie, and the colliery engineer, Walters, for not having had it removed.

Penalty imposed on Mr. M'Ghie, the colliery manager.

In pursuance of instructions which I had the honour to receive from the then Secretary of State, Mr. M'Ghie was summoned for not having provided an indicator, and for two other infractions of the law. He pleaded guilty, and was fined by the magistrates, Boaz Bloomer, Esq., an iron and coal master in the same district, and John E. Bealey, Esq., 10*s.* and costs in each case; a very light penalty, considering that the provision of an indicator would, according to the statement of the engineman, have rendered unnecessary the use of the token, from which this dreadful accident clearly resulted. The absence of an indicator and of the other apparatus required by law is the more to be wondered at as generally the colliery ranks amongst the best appointed in the district.

How four lives might have been saved.

Besides those killed at Cannock Chase, 15 lost their lives from various causes at other collieries in the district, making the total number in shafts 21, and of these four fell from the surface, all of whom might have been saved by the adoption of what is termed a "travelling fence," a provision I first called attention to in my annual Report of 1865. I know of no other apparatus of the kind for open working shafts, and this is simple, safe, and inexpensive. It is therefore to be regretted that the owners and agents, with few exceptions, are so slow and apparently so unwilling to adopt it. In the event of any alteration in the law for the better regulation and inspection of mines, I cannot too strongly recommend the insertion of a clause which shall render compulsory the use of this or some similar apparatus.

Accident No. 28 shows disregard of the special rules and great indifference to danger alike by the deceased and the charter-master. The former had finished his work as a pikeman in a level which was being driven in a lower measure, and whilst ascending the shaft on the "band or coupling chain" his head came into contact with the scaffold, he fell, and was killed. It appeared that the charter-master stood on the scaffold at the time to guide him through the aperture, though he knew that such a mode of raising men is strictly prohibited by the rules, and that provision should have been made for the free passage of the tackled skip. The jury, at the inquest upon the body, returned a verdict of "accidental death."

The agent of the colliery, however, immediately summoned the charter-master before the magistrates at Dudley for a violation of the 23d special rule and he was fined 10*s.* and costs.

There was a very unusual accident at the Brierley Colliery, No. 31 on the list. The unfortunate deceased, the charter-master, was descending the shaft with another man when the skip lodged on a "biatt," which had been floated out of an upper "level." The water had left one end resting in the level and the other on the walling of the shaft. This unexpected obstruction caused the skip to *cant* and the unfortunate man to relax his hold of the tackle and fall to the bottom. He lingered on till next day, when he died of the injuries sustained by the fall. The other man held firm hold of the tackle and was saved. This is another instance of death which might have been avoided by using the safety-chain.

One life, No. 43 in the list, was lost through overwinding.

How fatal accidents sometimes unfortunately happen through negligent enginemen.

In this instance the charter-master was descending the shaft, and when within a few yards of the bottom he stopped to repair the water-pipes. He afterwards gave the signal to ascend, which was duly observed, but the engineman neglected to stop his engine at the right place, and drew the unfortunate man over the pulley, by which he was fatally injured and died next day.

The engineman's only plea at the inquest was that, in consequence of the deceased not going to the bottom of the shaft, the "bell" attached to the "indicator" did not ring as usual, and therefore deceived him, which on investigation I found to be correct. This, however, was no answer to the charge of neglect, as the indicator itself should have been his guide and not the "bell."

The engine was under easy control, so much so that without the aid of the break the "band" could be regulated to an inch or so, in point of fact, for an engine and winding gear of that class, there was nothing to complain of.

Result of the verdict of manslaughter against the engineman.

Evidence to that effect was given before the coroner at the inquiry, at the close of which the jury returned a verdict of manslaughter against the engineman. The bill of indictment, however, was ignored by the grand jury at the Stafford Midsummer Assizes, though this was one of the clearest and grossest cases of overwinding through neglect that has come under my notice.

No. 80 in the list occurred to a lad who, whilst attempting to cross over the "sump," fell through the scaffold, owing to the absence of one of the "planks," which contrary to the special rules the deputy manager had permitted to be removed, and hence the accident and subsequent death of the unfortunate youth.

In accordance with your instructions the deputy was afterwards summoned before the Stourbridge magistrates, and the full penalty of 40*s.* and costs was imposed.

Eighty-eight in the list, and the last requiring any special notice, occurred at the Ettingshall Colliery, belonging to H. B. Whitehouse, Esq.

The pit in question was at that time in the possession of and worked by a charter-master named, Jackson, who, it appeared, on the morning of the accident did not as usual reach the pit in time to arrange with and see the workmen descend. The deputy, however, took the workmen down the pit and commenced operations, leaving two "boys" under 15 years of age in charge on the pit bank, contrary to the provisions of the statute.

During the morning of the day on which the accident occurred, as these "boys" were engaged at the mouth of the pit-shaft, the gin-driver, and the younger of the two, fell down the shaft and was killed; the sad result of leaving *children* in charge of such important and dangerous work.

In obedience to your commands the charter-master, Jackson, has since been summoned before Isaac Spooner, Esq., and fined the minimum penalty of 20*l.* and costs.

Miscellaneous Accidents.

Underground management by a charter-master and his deputy, and the sad consequences resulting therefrom.

An accident under this heading, 23 in the list, caused the loss of five lives out of the 18 classed under this heading, and only one less than the Cannock Chase catastrophe. It took place at the Clattershall Colliery on the 11th of March, and furnishes a striking proof of the looseness and disregard of general directions which is often exhibited in the mines of South Staffordshire. The workings were old and somewhat extensive, and a portion of them, which were on fire, was cut off from the part in which coal was being got by "dams" built across the air-course. Ventilation was secured by a lamp-fire in the up-cast shaft, and Mr. Groucutt, the colliery manager, had given Shaw, the charter-master, strict orders to keep up this fire constantly, leaving him no discretion in the matter. One of the fire dams which was near the up-cast shaft leaking, the charter-master directed his deputy, a man named Chivers, to repair it by placing sand against it, and told him to lower the sand by the winding or downcast shaft, and to convey it thence to the dam. Chivers, however, insisted that this was a needless trouble, and proposed to take out the lamp-fire and throw the sand down the up-cast shaft, and Shaw, after some dispute, yielded to his wishes. The result was that Chivers and four others lost their lives by an accumulation of "choke-damp."

Result of "Shaw's" trial.

Shaw, the charter-master, was committed by the coroner's jury for "manslaughter," but on being tried at the assizes at Stafford was acquitted.

Carbonic acid gas proved fatal to a boy employed at the Willenhall Road Colliery. This case stands No. 2 in the list. At the pit in question a headway was being driven towards another shaft, and was ventilated by sheet-iron tubing attached to a fan on the surface.

A life lost through an indiscreet and cowardly deputy.

On the morning of the accident, the man in charge of the mine took the deceased and another boy down the pit, and on his examination of the headway he found a little gas at the far end of the drift. He at once went back to the pit bottom to give orders for the fan to be driven faster. Meanwhile, however, he sent one of the boys to fetch a tool which he had left by the side of the burning candle not far from the gas, telling him at the same time not to go beyond the candle. As the boy did not quickly return, the second boy was sent after him, who immediately came back to the man at the bottom, saying that "he could not bring the deceased out as he had gone beyond the candle and was got down by the damp." The man went at once to his rescue, and might have saved him, but he was too great a coward to make the attempt, and allowed the poor boy to perish before his face, which might have been avoided by timely assistance, as the gas did not prevent another man rushing into the place in the hope of bringing the boy out alive, a noble act, which, however, was unfortunately performed too late.

It was decidedly wrong and cruel in the first instance to send the boy into such a place at all, and much worse to stand by and witness his death without making any attempt to effect his rescue. Such persons are totally unfit to be intrusted in any way either with the care of mines, or the persons employed therein.

Iow many ives are lost.

Accidents, No. 17, 18, 21, and 76 were brought about from the timber settings giving way, either from "bumps," superincumbent weight, or lateral pressure, which generally speaking, causes the settings to reel and eventually slip out, thus allowing the "gobbing" or "loose coal and dirt" to rush down, burying everything and smothering everybody who may unfortunately happen to be under at the time.

Whenever more than one setting of timber is erected, they should be so fastened together as to prevent the trees or props from reeling or slipping out, a precaution which I have never ceased to impress upon the minds of underground managers.

Another case of suffocation, 82 in the list, happened at one of Lord Dudley's old rib and pillar pits in the Wallows Colliery. This mine has for some time past been more or less subject to spontaneous fire, and has been a source of much anxiety and trouble to the agents, in checking its continual ravages and encroachments on the solid coal.

When indications of its presence appear, it is customary to erect dams in the "bolt holes" and headways, and it very frequently requires a temporary stoppage of the entire works.

Another death owing to the want of competent supervision.

In this instance "dams" had been built in the headways to prevent the spread of the fire during the absence of the workpeople from Saturday night till the Monday morning following. On resuming work the deceased with several others, including the charter-master, succeeded in removing one of these dams, but in making an attempt to reach the second he was overcome and suffocated by the gases given off through the pores of the dam and fractured coal.

[illegible] ce was given at the inquest that the charter-master and several other workmen, i[illegible] the deceased man's brother, were within a few yards of him, and seeing that he [illegible] instantly return they followed and discovered his body, but were afraid to sna[illegible]t, and thus he was left to perish in the vitiated air, and some considerable time [illegible] before his body was recovered. It was also stated at the inquest that the un[illegible]ate man was cautioned not to go beyond a point where his candle ceased to burn, [illegible]tement his brother corroborated.

H[illegible]rter-master possessed a competent knowledge of the deadly nature of th[illegible] would never have permitted this man to have run such a risk.

[illegible]r d[illegible]s were caused by accidents on the surface, one by machinery, one by the [illegible]sting [illegible] a boiler, one on a railway, which should hardly perhaps have been classed amongst mining accidents, and the fourth was the case of a boy run over by a loaded tub. With regard to the boiler explosion (52 in the list) at the Brierley Colliery, the boy who lost his life was not employed there at the time. This death, however, is included in the list. From my examination of the boiler it appeared evident that its bursting was due to over-pressure, and in all probability shortness of water.

Considering the very large number of steam boilers employed in this district these accidents I am happy to say are of comparatively rare occurrence.

Convictions.

Proceedings for infractions of the law have been less numerous than in 1867. The fines imposed amount in the aggregate to 70*l.* 17*s.* 6*d.*

	£	*s.*	*d.*
The Worcester and County Banking Company, Cricket Field Colliery	30	0	0
Mr. Richmond, Bromley Lane Colliery, owner	30	0	0
Mr. M'Ghie, Cannock Chase Colliery, manager	1	10	0
Mr. Davis, Beechdale Colliery, owner	3	0	0
Mr. Watkis, Meadows Colliery, charter-master	0	5	0
Mr. Owen, Brownhills Colliery, charter-master	0	2	6
Mr. Nock, Hilly Colliery, owner	2	0	0
Mr. Bloomer, Sneyd Lane Colliery, owner	1	0	0
Mr. Turner, Whimsey Colliery, owner	1	0	0
Mr. Townsend, Whimsey Colliery, owner	2	0	0
	£70	17	6

Besides these, there have been several informations laid by the owners or agents of collieries against their workpeople which have resulted in convictions, and the penalties will no doubt in due course be paid over to the proper authorities.

Ironstone Mines.

During the year 1868 eleven separate fatal accidents have occurred in these mines, which resulted in as many deaths, being an increase of three over the previous year. They were less, however, than in 1866.

Six were caused by falls, three in shafts; one is classed as miscellaneous underground, and one on the surface. The general observations with regard to accidents in coal mines equally apply to these, which are sufficiently described in the list. One case, however, worthy of special mention, occurred at the Netherton Colliery of Messrs. Grazebrook, and affords a remarkable instance of reckless carelessness by one of the workmen named Thomas Pritchard. He was carrying to the pit top some timber props for use in the mine, and, whether by accident or intention, threw one down the shaft, which, striking the hooker-on at the bottom, killed him on the spot.

The jury at the inquest returned a verdict of manslaughter, and pleading guilty at the Worcester assizes he was sentenced to two months imprisonment with hard labour.

Several persons have as usual lost their lives who were not in any way employed at the collieries of the district, and have therefore no place in the list. At Brownhills a boy seven years old was improperly allowed to ride on the trucks of a tramway, fell off, and was killed.

In another instance a youth went to one of the pits at the Bradley Lodge Colliery, jumped into the skip in the absence of the banksman, and descended with another boy

He went into the workings, and no one being there to prevent him, ran about the mine, when he was killed by a fall. Again, several lads were playing on one of the pit banks of the Willenhall Road Colliery, when one of them ran to the balance chain, and sliding down a few yards, at length fell to the bottom and was killed.

I have, &c.
(Signed) JAMES P. BAKER.

To the Right Hon.
Henry Austin Bruce, D.C.L., M.P.,
Secretary of State, Home Department,
London.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS of LIFE arising therefrom, in the SOUTH STAFFORDSHIRE AND WORCESTERSHIRE DISTRICT, during the Year ending 31st December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost. Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.														
Jan. 1	1	Wall End -	Bloxwich -	R. Thomas - -	J. Flynn - -	Bondsman -	—	Fall of coal from a "slip" on the side of a gate road.	–	1	–	–	–	1
" 6	2	Willenhall Road	Wolverhampton	J. Edge and Co. - -	S. Bellingham -	Collier boy	—	Suffocated by carbonic acid gas -	–	–	–	1	–	1
" 7	3	Pool Meadow -	Willenhall -	Chillington Company -	W. Hill - -	Bondsman -	50	Fall of new-mine coal, which deceased had neglected to timber.	–	1	–	–	–	1
" 10	4	Cannock and Rugeley.	Rugeley -	Cannock and Rugeley Colliery Company.	P. Lonch - -	Collier -	20	Run over by railway truck -	–	–	–	–	1	1
" 11	5	Trentham -	Willenhall -	Trentham Colliery Company.	R. Wynne -	Pikeman -	50	Fall of coal whilst holing in new mine coal; injured on the 9th instant, died this day. Had neglected to sprag.	–	1	–	–	–	1
" 15	6	Keeling -	West Bromwich	H. Wythes -	D. Mills -	Collier boy	14	Fell down pit shaft - - -	–	–	1	–	–	1
" 16	7	Homer Hill -	Stourbridge -	S. Evers and Sons -	E. Downing -	Bondsman -	—	Fall of coal in thick coal pit -	–	1	–	–	–	1
" 20	8	Tividale Hall -	Dudley - -	S. Bradley - -	J. Davies - J. Sperrings -	Ditto - Ditto -	48 15	Fall of coal in thick coal pit from between 3 slips, the result of a "bump."	–	2	–	–	–	2
" 21	9	Prince of Wales	Ditto - -	Taylor and Davies -	J. Bull and another - -	Pikeman -	38 34	Fall of overhanging coal in thick coal pit, the result of a "bump" which knocked the timber out. Injured on the 20th, died this day.	–	2	–	–	–	2
" 22	10	Brereton -	Rugeley -	Earl of Shrewsbury -	H. Sleigh - -	Ditto -	64	Fall of coal from the face on the 17th; died this day.	–	1	–	–	–	1
" "	11	Cannock Chase	Lichfield -	Cannock Chase Colliery Company.	R. Hicken -	Collier boy	—	Crushed between tubs - -	–	–	–	1	–	1
" 28	12	Old Park - -	Dudley - -	Earl of Dudley - -	S. Jones - -	Bondsman -	24	Fall of coal in thick coal pit from a slip.	–	1	–	–	–	1
" "	13	Kitsfield -	Deepfield -	J. Bryan - - -	D. Timmins -	Banksman -	—	Fell into pit shaft - - -	–	–	1	–	–	1
								Carried forward -	–	10	2	2	1	15

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
								Brought forward -	–	10	2	2	1	15
1868. Feb. 29	14	Whitehall -	West Bromwich	J. Kendrick - - -	J. Didcote -	Sinker -	—	Whilst doing repairs in pumping pit, a setting of brickwork slipped out, and precipitated deceased down the shaft.	–	–	1	–	–	1
" 30	15	Corbyn's Hall -	Kingswinford -	W. Beardmore and Co. -	G. Williams -	Bondsman -	34	Fall of coal in thick coal whilst removing timber.	–	1	–	–	–	1
" 31	16	Foxyards -	Tipton - -	Earl of Dudley - -	W. Gibbons -	Pikeman -	24	Was attempting to get down some "stone coal" when it suddenly fell and killed him on the spot.	–	1	–	–	–	1
Feb. 7	17	Bradley -	Bilston - -	J. Bagnall and Sons -	T. Ellis - -	Bondsman -	51	Deceased was removing slack from under a large piece of coal, when it rolled over and displaced the timber settings under the roof, a portion of which fell, and killed him.	–	–	–	1	–	1
" 29	18	Bourne Hill -	Rowley Regis -	Messrs. Nock - -	J. Dudley - W. Morris -	Bondsman - Ditto -	16 —	Suffocated by a fall of loose coal and dirt caused by a "bump" which forced the timber settings out.	–	–	–	2	–	2
Mar. 2	19	Highfields -	Bilston - -	Barbor's Field Company -	S. Whitehurst -	Bondsman -	—	Injured by fall of roof on the 2d January; died this day.	–	1	–	–	–	1
" 6	20	Ketley	Kingswinford -	W. Beardmore and Co. -	J. Pugh - -	Ditto -	47	Fall of coal in thick coal pit; whilst removing timber.	–	1	–	–	–	1
" 9	21	Coneygree -	Tipton - -	Earl of Dudley - -	J. Sherwood -	Collier boy	15	Suffocated by fall of slack in gate road owing to the timber settlings reeling out.	–	–	–	1	–	1
" 11	22	Tipton Moat	Ditto - -	Tipton Moat Colliery Co.	J. Jephson -	Pikeman -	28	Fall of rock in gate road, brought about by an improper removal of timber.	–	1	–	–	–	1
" "	23	Clattershall -	Brierley Hill -	E. Bowen - -	J. Chivers and 4 others -	Deputy -	—	Suffocated by carbonic acid gas -	–	–	–	5		5
								Carried forward -	–	15				

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.								Brought forward -	–	15	3	11	1	30
Mar. 11	24	Salt Well -	Netherton -	Earl of Dudley - -	B. Robinson -	Bondsman -	22	Fall of white coal in thick coal-pit. Too high to be practically supported with timber.	–	1	–	–	–	1
„ 13	25	Hange -	Oldbury -	Messrs. Round - -	D. Barratt -	Collier boy	—	Fall of coal in thick coal pit from between two slips caused by a "bump."	–	1	–	–	–	1
„ „	26	Cannock Chase	Lichfield -	Cannock Chase Colliery Company.	H. Watkins -	Horse-driver	—	Kicked by the horse he was driving on the 12th; died this day.	–	–	–	1	–	1
	27	Withymoor -	Netherton -	W. H. Dawes - -	R. Perkins -	Collier boy	14	Fall of coal in brooch coal mine, the result of a sudden and unexpected subsidence of the supercumbent strata.	–	1	–	–	–	1
April 9	28	Salt Well -	Ditto - -	Earl of Dudley - -	J. Danks - -	Pikeman -	40	Whilst improperly ascending on the foot hook of the band chain he fell, and was killed.	–	–	1	–	–	1
„ 18	29	Old Park -	Kingswinford -	Ditto - - -	R. Aston -	Ditto -	40	Premature explosion of a shot; brought a fall of coal down upon him.	–	1	–	–	–	1
„ 26	30	Homer Hill -	Stourbridge -	S. Evers and Sons -	J. Wood - -	Ditto -	–	Injured by fall of coal on the 18th ultimo; died this day. The sad result of neglecting to sprag the coal whilst holing in thick coal pit.	–	1	–	–	–	1
May 4	31	Brierley -	Coseley - -	J. Yardley - -	S. Beddow -	Charter Master.	61	Fell out of a skip whilst descending	–	–	1	–	–	1
„ 8	32	Hinley -	Kingswinford -	Earl of Dudley - -	S. Flavel - -	Deputy -	45	Fall of coal whilst removing a cog, in thick coal pit.	–	1	–	–	–	1
„ 15	33	Cannock Chase	Lichfield -	Cannock Chase Colliery Company.	T. Richards and 5 others.	Colliers -	40	Whilst descending the wire rope snapped.	–	–	6	–	–	6
								Carried forward -	–	21	11	12	1	45

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.								Brought forward -	–	21	11	12	1	45
May 18	34	Bradley -	Bilston - -	G. B. Thorneycroft and Company.	I. Whittle -	Hanger-on -	15	Grasped the foot hook of the "band chain" for amusement, and rode up shaft several yards, let go, fell, and was taken up dead.	–	–	1	–	–	1
" 22	35	New Brownhills	Brownhills -	Conduit Colliery Company	J. Robinson -	Collier boy	13	Crushed by a "tub" on the 16th instant; died this day.	–	–	–	1	–	1
" 27	36	Barn Farm -	Darlaston -	S. Speake - -	W. Mathews -	Bondsman -	—	Fall of rock in gate-road whilst improperly drawing timber props which deceased had been cautioned not to interfere with. He, however, still persisted in their removal and lost his life.	–	1	–	–	–	1
June 3	37	Fly - -	Corngreaves -	New British Iron Company.	W. Piper - -	Deputy -	43	Fall of coal in thick coal pit, the result of removing timber props.	–	1	–	–	–	1
" 15	38	Hilly - -	Oldbury -	Nock and Potter - -	E. Smith - -	Bondsman -	—	Fall of roof in thick coal pit opening	–	1	–	–	–	1
" 26	39	Lower Moor -	Brierley Hill -	E. Cooper - -	H. Watts - -	Ditto -	57	Injured by a fall of overhanging coal which he was trying to get down on the 12th instant; died this day.	–	1	–	–	–	1
" 28	40	Wood Farm -	Bloxwich -	Jeavons and Mitchell -	H. Garattley -	Pikeman -	—	Explosion of fire-damp on the 16th instant; died this day.	1	–	–	–	–	1
July 1	41	Millfield -	West Bromwich	T. Millership - -	E. Millership and son of the owner.	Assistant Manager.	24	Fall of roof from between two slips not previously seen.	–	1	–	–	–	1
" 4	42	Tividale Hall -	Dudley - -	S. Bradley - -	H. Harrington -	Bondsman -	48	Fall of coal in thick coal; caused by a "bump."	–	1	–	–	–	1
" 7	43	Capponfield -	Bilston - -	D. Jones and Sons -	W. Jones - -	Charter Master.	54	Overwinding. Injured on the 6th; died this day.	–	–	1	–	–	1
" "	44	New Bearmoor	Cradley - -	New British Iron Company - - -	J. Granger - H. Bywater -	Bondsman - Ditto -	40 —	Fall of coal in thick coal mine -	–	2	–	–	–	2
								Carried forward -	1	29	13	13	1	57

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.								Brought forward	1	29	13	13	1	57
July 9	45	Wallows	Brierley Hill	Earl of Dudley	J. Batham	Pikeman	28	Having drilled a hole for a shot, he was in the act of reaching the powder to charge it, when the coal suddenly fell upon him.	–	1	–	–	–	1
„ 10	46	Fishley	Pelsall	Fishley Colliery Company	T. Onions	Bondsman	38	Fall of roof, the result of insufficient timbering.	–	1	–	–	–	1
„ 11	47	Black Waggon	West Bromwich	P. Williams and Company	T. Whitehouse	Collier boy	—	Crushed by a skip	–	–	–	1	–	1
„ 12	48	Blowers Green	Dudley	B. Cartwright	T. Cooper	Bondsman	30	Injured on the 3d instant, by fall of coal; died this day.	–	1	–	–	–	1
„ 25	49	Fullwoods End	Coseley	D. Smith and Co.	J. Huteley	Pikeman	65	Injured by fall of roof in gate road of a thick coal pit on the 17th instant, brought about by a "bump," died this day.	–	1	–	–	–	1
„ 29	50	Eagle or Springfield.	West Bromwich	Eagle Colliery Company	D. Venables	Collier boy	14	Fall of coal in thick coal pit, which was forced off a pillar by a "bump."	–	1	–	–	–	1
Aug. 14	51	Moxley	Bilston	S. Groucutt and Co.	S. Tonks	Pikeman	36	Fall of coal	–	1	–	–	–	1
„ 17	52	Brierley	Bilston	J. Yardley	J. Shaw	Collier boy	14	Explosion of a boiler	–	–	–	–	1	1
„ 21	53	Fullwoods End	Coseley	Messrs. Turley	G. Oliver	Hanger-on	15	Whilst improperly standing in pit bottom he was struck on the head and killed. Too young for such employment.	–	–	1	–	–	1
„ 22	54	Wallows	Brierley Hill	Earl of Dudley	J. Rowland	Pikeman	41	Fall of coal from side of a pillar in thick coal pit, caused by a "bump."	–	1	–	–	–	1
								Carried forward	1	36	14	14	2	67

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.								Brought forward	1	36	14	14	2	67
Aug. 28	55	Salt Well	Netherton	Earl of Dudley	M. Buttler	Bondsman	40	Fall of a very small piece of white coal in thick coal pit. The injury seemed so slight that the deceased walked most of the way towards his home. He however, when within a short distance of his residence, fell down insensible and expired same day.	–	1	–	–	–	1
Sept. 9	56	Cotsal	Corngreaves	New British Iron Company	W. Jones	Pikeman	—	Injured by fall of coal in a thick coal pit whilst cutting a back spurn out on the 7th instant; died this day.	–	1	–	–	–	1
„ 15	57	Spring Vale	Bilston	Union Coal Company	W. Ray	Bondsman	52	Fall of coal in fire-clay coal pit, knocked timber out.	–	1	–	–	–	1
„ 23	58	Black Heath	Rowley Regis	A. H. Dawes	W. Sheppard	Pikeman	40	Fall of coal in thick coal pit, the result of a "bump," which forced the timber out of its place.	–	1	–	–	–	1
„ 26	59	Himley	Kingswinford	Earl of Dudley	T. Smith	Bondsman	39	About two tons of fallen coal rolled over *en masse* and crushed him to death in thick coal pit.	–	–	–	1	–	1
Oct. 8	60	Moat	Tipton	Tipton Moat Colliery Company.	J. Thomas	Ditto	—	Injured by fall of roof on the 2d of April; died this day.	–	1	–	–	–	1
„ 14	61	Spring Vale	Bilston	Union Coal Company	T. Arnold	Assistant Deputy.	42	Fall of coal, the too frequent result of neglecting to timber.	–	1	–	–	–	1
„ 21	62	Himley	Kingswinford	Earl of Dudley	W. Greenway	Bondsman	23	Fall of "stone coal" (150 lbs.) from off the side of a cog about 6 feet high.	–	1	–	–	–	1
„ 23	63	Rowley Hall	Rowley Regis	Wright and North	A. Latham	Charter master.	42	Fall of overhanging coal in gate road, thick coal pit.	–	1	–	–	–	1
								Carried forward	1	44	14	15	2	76

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
								Brought forward -	1	44	14	15	2	76
1868. Oct. 23	64	Shut End New	Dudley - -	Messrs. Cochrane -	E. Bytheway -	Pikeman -	29	Injured by fall of coal in thick coal pit on the 10th instant; died this day.	–	1	–	–	–	1
„ 27	65	Spring Vale -	Bilston - -	Union Coal Company -	W. Taylor -	Ditto -	36	He was cutting "tops" in a bottom coal pit, which he had not took the precaution to prop with timber.	–	1	–	–	–	1
„ 28	66	Groveland -	Dudley Port -	J. Bagnall and Sons -	R. Cooper -	Collier boy	15	Crushed to death by a skip -	–	–	–	1	–	1
„ 30	67	Himley -	Kingswinford -	Earl of Dudley - -	J. Oakley - -	Pikeman -	34	The deceased, the charter-master, and the deputy were trying to throw some over-hanging coal with "levers," when, suddenly and unexpectedly, a mass of "brazils" fell, killing Oakley, and injuring the other two men. Thick coal pit.	–	1	–	–	–	1
„ „	68	Salt Well -	Netherton -	Earl of Dudley - -	C. Bridgwater	Bondsman -	17	Injured slightly by a fall of "patchels" in thick coal pit on the 29th instant; died this day.	–	1	–	–	–	1
Nov. 4	69	Conduit -	Brownhills -	Conduit Colliery Company	J. Brindley -	Engineer -	34	Deceased and another were engaged changing the "bucket" in the pumping and winding pit, when the chain which suspended the "bucket-door" snapped and precipitated Brindley to the bottom.	–	–	1	–	–	1
„ 11	70	Withymoor -	Rowley Regis -	Messrs. Nock - -	W Barnett -	Labourer -	38	Fell into pit shaft - - - -	–	–	1	–	–	1
„ 12	71	Ketley - -	Kingswinford -	Corbyn's Hall Colliery Co.	J. Alcock -	Engineer -	35	Whilst repairing the fly-wheel fence, he fell over it upon the fly-wheel race, when the crank of the engine struck him, inflicting injuries so serious that he died same day.	–	–	–	–	1	1
								Carried forward -	1	48	16	16	3	84

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.								Brought forward -	1	48	16	16	3	84
Nov. 12	72	Cathedral -	Brownhills -	W. Harrison - -	A. Glover -	Bondsman -	17	Fall of coal off the face in "thin-mine."	–	1	–	–	–	1
" 13	73	Old Park -	Dudley - -	Earl of Dudley - -	W. Hall - -	Horse-driver	15	Knocked down and run over by a tub on surface.	–	–	–	–	1	1
" 17	74	Sampson -	Oldbury -	R. Haines - -	G. Harley. -	Collier boy	—	Fall of "lambs" in thick coal pit, the result of a "bump."	–	1	–	–	–	1
" 18	75	Park Head -	Dudley - -	Evers and Martin -	J. Hughes -	Hooker-on	18	Brick fell down pit shaft whilst he was improperly standing in the bottom.	–	–	1	–	–	1
" 19	76	Foxyards -	Tipton - -	Earl of Dudley - -	J. Perry - -	Bondsman -	40	Suffocated by loose gob, which rushed down upon him from side of stall in an old rib and pillar pit.	–	–	–	1	–	1
" 20	77	Whitehall -	West Bromwich	J. Kendrick - -	W. Sharratt -	Blacksmith	—	Walked into the working pit shaft -	–	–	1	–	–	1
" 23	78	Tividale Hall -	Dudley - -	S. Bradley - -	R. Bowater - R. Cambridge -	Deputy - Bondsman -	25 —	Injured by an explosion of fire-damp on the 14th instant; died this day.	2	–	–	–	–	2
" 24	79	Moat - -	Tipton - -	Tipton Moat Colliery Co.	W. Baker -	Hooker-on -	44	Crushed by cage whilst he was improperly standing in the bottom.	–	–	1	–	–	1
" 26	80	Cradley Park -	Cradley - -	J. King and Co. - -	E. Robinson -	Colliery boy	—	Fell into sump on the 24th instant; died this day.	–	–	1	–	–	1
" 27	81	Portway Hall -	Oldbury -	W. H. Dawes - -	W. Holden -	Pikeman -	50	Fall of coal in thick coal pit. He and another workman were taking out the spurns and timber to throw a fall, when a "bump" forced a piece of coal upon him.	–	1	–	–	–	1
" 30	82	Wallows -	Brockmoor -	Earl of [illegible] -	J. Raybould -	Bond-deputy	22	Suffocated by carbonic acid gas -	–	–	–	1	–	1
" "	83	Fullwood's End	Coseley - -	Messrs. Smith - -	J. Davies -	Collier boy	12	Fall of coal in thick coal pit, brought about by a "bump."	–	1	–	–	–	1
								Carried forward -	3	52	20	18	4	97

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost. Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.								Brought forward -	3	52	20	18	4	97
Dec. 5	84	Wyrley Cannock	Cheslyn Hay -	Wyrley Cannock Colliery Company.	S. Morgan -	Pikeman -	30	Fall of coal from the roof, which deceased had been cutting, but neglected to prop with timber.	–	1	–	–	–	1
„ 11	85	Groveland -	Dudley Port -	J. Bagnall and Sons -	G. Russell -	Bondsman -	30	Fall of roof in this coal mine, occasioned by a "bump."	–	1	–	–	–	1
„ 15	86	Wallows -	Brierley Hill -	Earl of Dudley - -	W. Bagott -	Deputy -	48	Fall of coal in thick coal whilst in the act of removing a timber prop to fire a shot.	–	1	–	–	–	1
„ „	87	Barn Farm -	Bilston - -	S. Speak - - -	J. Casey - -	Collier boy	—	Fall of coal in new-mine - -	–	1	–	–	–	1
„ 17	88	Ettingshall -	Sedgley - -	H. B. Whitehouse -	W. Jarratt -	Gin-driver -	—	Fell into pit shaft - - - -	–	–	1	–	–	1
„ „	89	Wallows -	Brierley Hill -	Earl of Dudley - -	D. Allport -	Deputy -	42	Fall of coal in thick coal, about 2 cwt.	–	1	–	–	–	1
„ 24	90	Piercey - -	West Bromwich	T. Cox and Co. - -	J. Rushton -	Pikeman -	20	Fall of coal in thick coal pit, from between two converging slips, which might have been prevented by judicious timbering.	–	1	–	–	–	1
								Total - -	3	58	21	18	4	104

List of the FATAL ACCIDENTS and LOSS OF LIFE in IRONSTONE MINES in the SOUTH STAFFORDSHIRE and WORCESTERSHIRE DISTRICT, during the Year ending 31st December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Ironstone and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.														
Feb. 5	1	Willenhall Road	Wolverhampton	J. Edge and Co.	J. Fenn	Bondsman	—	Fall of ironstone measures	–	1	–	–	–	1
„ 29	2	New Priestfield	Willenhall	W. Ward and Sons	J. Giles	Horsedriver	14	Fall of roof	–	1	–	–	–	1
„ „	3	Spring Vale	Bilston	Union Coal Company	A. Walters	Sinker	32	Whilst descending, the cotter belonging to the gin shafts fell out, which allowed the gin wheel to revolve rapidly, precipitating the unfortunate man to the bottom.	–	–	1	–	–	1
Mar. 20	4	Willenhall New	Willenhall	Fletcher, Solly, and Co.	J. Round	Collier boy	14	Fall of ironstone measures	–	1	–	–	–	1
Apr. 25	5	Netherton	Netherton	Messrs. Grazebrook	A. Pritchard	Hooker-on	15	Struck by a piece of timber which a miner threw down the shaft.	–	–	1	–	–	1
June 3	6	Parkfield	Wolverhampton	Parkfield Company	J. H. Fletcher	Miner	13	Kicked by a pit horse	–	–	–	1	–	1
Sept. 1	7	Willenhall New	Willenhall	Fletcher, Solly, and Co.	A. Cosdrift	Ditto	—	Fall of ironstone measures	–	1	–	–	–	1
Oct. 14	8	Woodwell	Bloxwich	Messrs. Bloomer	P. Griffin	Hooker-on	—	Injured by cage on the 19th ultimo; died this day.	–	–	–	1	–	1
„ 30	9	Moat	Tipton	Moat Colliery Company	J. Gould	Miner	18	Fall of gubbin ironstone in gate-road on the 29th; died this day.	–	1	–	–	–	1
Nov. 14	10	Darlaston Green	Darlaston	Darlaston Steel and Iron Company.	R. Slater	Bondsman	45	Fall of roof which deceased was trying to get down.	–	1	–	–	–	1
„ 16	11	Friar Park	West Bromwich	W. H. Dawes	J. Burley	Engineman	19	Got entangled in the winding machinery, of which he had the charge.	–	–	–	–	1	1
								Total	–	6	2	2	1	11

Mr. Wales' Report.

REPORT on the WORKING of the MINES INSPECTION ACT (23 & 24 Vict. c. 151.) for the SOUTH WALES DISTRICT, for the Year ended 31st December 1868.—By THOMAS E. WALES, Esq.

SIR, Swansea, 27th February 1869.

As Inspector of Mines for the South Wales District, I have the honour to transmit to you herewith my report for the year ended December 31st, 1868.

The number of fatal accidents and loss of life arising therefrom are, I am happy to state, considerably less than the previous year, as will be seen from the following figures:—

Total lives lost in	1867 - -	309
Ditto	1868 - -	104
Less in 1868	- -	205

The following monthly statement will show when and how these accidents have occurred:—

MONTHLY STATEMENT of DEATHS caused by ACCIDENTS in the COAL MINES of the SOUTH WALES DISTRICT in the Year 1868.

—	Explosions.	Falls of Coal.	Falls of Stone.	Suffocation.	In Shafts.	Miscellaneous.	On surface.		TOTAL.
							Machinery.	Miscellaneous.	
January - - - - -	2	3	3	—	—	2	—	2	12
February - - - -	—	3	4	—	—	1	—	—	8
March - - - -	1	—	3	—	—	4	—	1	9
April - - - -	—	3	—	—	2	5	—	2	12
May - - - -	1	—	6	4	1	2	—	—	14
June - - - -	—	—	4	—	1	1	—	—	6
July - - - -	—	—	1	—	1	3	—	1	6
August - - - -	—	—	2	—	1	2	—	—	5
September - - -	—	2	2	—	—	3	—	—	7
October - - - -	—	—	4	1	1	4	—	—	10
November - - -	—	—	4	—	—	2	—	—	6
December - - -	—	1	4	—	1	2	1	—	9
Total - - -	4	12	37	5	8	31	1	6	104

And the following tabular form will show the per-centage of fatal accidents and persons killed, the quantity of coal raised per fatal accident, and quantity of coal raised per life lost:—

	Year 1868.	Year 1867.
Computed number of persons employed -	29,300	29,300
Quantity of coal raised in tons - -	9,000,000	9,376,443
Number of fatal accidents - - -	100	119
Number of lives lost by ditto - -	104	309
Persons employed per fatal accident - -	293	246
Persons employed per life lost - -	281	95
Tons of coal raised per fatal accident - -	90,000	76,406
Tons of coal raised per life lost - -	86,538	29,425

Explosions of gas.

Three explosions have occurred during the year, causing the loss of four lives.

The first took place in the Tila Coch Colliery, Rhondda Valley, on the 23d of January, resulting in the loss of two lives.

This explosion was caused by the reckless conduct of one of the colliers in removing the top from his safety lamp, and exposing a naked light in his place where there was a small " blower " giving off gas. He was himself rather severely burned.

This pit is sunk to the steam coals which give off large and not unfrequently sudden discharges of inflammable gas, and was worked with safety lamps, but the general discipline was of the worst description ; the workmen being permitted to work with their safety lamps unlocked.

With the permission of the Secretary of State, proceedings were instituted against the owner, Mr. Thomas Jones, for an infringement of the third general rule, 23 & 24 Vict. Cap. 151., and a fine of 10*l.* was imposed.

The second explosion occurred in the Worcester Colliery, near Swansea, belonging to Messrs. Glasbrook and Co., on the 12th of March.

This colliery is not deep and by no means a fiery one, and it is worked with naked lights.

On the morning in question the "fireman," in making his morning's examination of the colliery, discovered a small quantity of gas lodged in the face of a certain heading.

He very properly fixed a danger signal to indicate the fact, and also acquainted the person (who happened to be his son) of it; but in the face of both precautions the unfortunate man, who was about 23 years of age, went past the danger signal with an open light, fired the gas, and caused his own death.

The third explosion happened on the 16th of May in the Cwmdû Colliery, near Maesteg, belonging to Messrs. John Brogden and Sons, and resulted in the death of one person.

This is a non-fiery coal, and worked with naked lights.

By some means not explained a small quantity of gas accumulated in the face of a certain heading, which was exploded by the deceased's naked light.

Suffocation.

Two accidents have occurred from this cause, resulting in the loss of five lives.

On the 13th of May an explosion of gas took place in the Carnarvon Colliery, near Loughor, belonging to the Techon Coal Company.

This colliery is worked with locked safety lamps, and a few days prior to the one in question the pumping apparatus was broken; a quantity of water collected in a certain part of the colliery, which stopped the ventilation there; gas accumulated, which was fired by the " pitman's " (the person whose duty it is to attend to all the pumping arrangements) Clanny safety lamp.

From 20 to 30 colliers were at work some considerable distance from where the explosion took place, and none of them were burned, but unfortunately they had to pass through the "after-damp" (carbonic gas being the products of the explosion) on their road to the bottom of the shaft, and the four deceased succumbed to its deadly effects; the remainder of the men succeeded in gaining the shaft, and were saved.

The other case occurred October 21st, in an old shaft belonging to the Neath Abbey Coal Company, near Neath, and resulted in the death of one person.

The deceased with another person were engaged in clearing out an old shaft communicating with extensive old works from which carbonic gas was issuing.

The person who was engaged with the deceased had ascended the shaft to take some tools down, and returned in a few minutes, when, to his great surprise, he found his companion quite dead.

Doubtless, a somewhat large discharge of this gas had been given off, and rendered the man insensible, and unable to call up the shaft for assistance.

Falls of Stone and Coal.

It affords me great satisfaction to be able to report a considerable diminution in the number of deaths under this head,—

Total for 1868 being - - - -	49
Do. 1867 „ - - - -	67
Decrease in 1868 -	18

which I trust may, in some degree at least, be attributable to greater care on the part of both the colliers and officials, especially the former, on whom the responsibility of fixing proper and a sufficient quantity of timber principally devolves.

In this district it is the custom for the colliers to fix or set their own timber.

Shaft Accidents.

The number of deaths under this head is 8 as against 15 in 1867.

The great decrease is, I think, to be attributed for the most part to the sinking of fewer shafts than during the previous year.

Miscellaneous Underground Accidents.

The loss of 31 lives has occurred under this head, as against 30 in 1867.

1	death from an explosion of gunpowder;
8	do. by trams upon incline and engine planes;
21	do. by trams on horse and other roads; and
1	from sundries.
31	

The accidents under this head, which are more directly provided against by the Coal Mines Inspection Act, are those which occur on incline and engine planes. And in one instance (the London and Merthyr Colliery) I found the requirements of the Act had not been complied with.

With the permission of the Secretary of State, proceedings were instituted against the manager of the colliery, Mr. Davies, for an infringement of the 8th general rule, 23 & 24 Vict. c. 151., and a fine of 10*l.* was imposed by the magistrate, J. C. Fowler, Esq., which amount was given to the mother (a widow) of the deceased boy, in accordance with instructions received from the Secretary of State.

Surface.

Of the seven persons killed on the surface—

2 were crushed by trucks,
1 fell over a tip,
1 crushed by trams,
1 do. by a segment,
1 struck by a windlass handle, and
1 by machinery;

none of which, however, seem to call for any special remark.

I cannot conclude this my Fifth Annual Report without calling attention to the fact that out of the three explosions referred to (which happily were not attended with a great sacrifice of life, but it might have been otherwise) two were caused by a reckless disregard of the colliery rules. In one case (the Worcester Colliery) the unfortunate man fell a victim to his own recklessness; in the other two poor men were killed, and the offender was himself rather severely burnt.

Such reckless conduct cannot be too strongly condemned, and whenever detected legal proceedings ought always to be instituted against the offender.

Unfortunately many of the workmen have a stong inclination to conceal any breach of the rules committed by their fellow-workmen.

This makes it exceedingly difficult to discover infringements of the rules, and I fear few (unless fatal results have ensued, when a thorough investigation is made in the coroners' courts) are detected.

On the 9th instant three lives were lost by an explosion of gas in the Forchaman Colliery, caused by the firing of a shot, not only against the rules (shot firing being strictly prohibited in that part of the colliery) but also against the express orders of the fireman.

Two of the colliers who gave evidence at the inquest said that on the morning prior to the morning of the explosion they saw the hole ready for the powder to be put in, and that they knew shot firing was strictly prohibited.

One of them begged of the two deceased not to persist in firing a shot as it was against the rules, and because they all knew there was gas lodged on the top of a "fall" in an old heading exactly opposite the hole, and only 16 yards from it.

One of the deceased replied that if they had had the powder they would have fired the shot when they drilled the hole, but now they would not do so.

This was on the Monday morning, and the next morning (Tuesday) the same two men hurried into their working place and fired the shot which ignited the gas lodged close by and thus caused their own deaths as well as the death of another poor man who probably knew nothing of their intention to commit such a flagrant breach of the rules.

There were also other eight or nine persons who were proceeding to their working places more or less seriously burnt.

Although the two witnesses already referred to saw the officials of the colliery between the Monday morning (when they saw the hole ready to receive the powder) and the Tuesday morning, when the explosion occurred, they never mentioned the matter to one of them.

Had these men acted otherwise, proper steps could and no doubt would have been taken, and the loss of life prevented.

I have never met with a worse case than this, which is my only reason for referring to it here, for unless different conduct be pursued by the workmen I despair of any diminution of those terrible accidents being effected, if indeed they can be called accidents.

Ironstone Mines under the Coal Mines Inspection Act.

Eight lives have been lost in those mines during the past year, as against six in 1857, viz.:—

Five in the mines belonging to the Dowlais Iron Company; three from falls of roof and two from stones falling down shafts.

Two in the mines belonging to the Plymouth Iron Company, both from falls of roof; and

One in the mines belonging to R. T. Crawshay, Esq.

I have, &c.
(Signed) Thos. E. Wales.

The Right Honourable
Henry A. Bruce, M.P., &c.
Home Secretary,
Whitehall, London.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS of LIFE arising therefrom, in the SOUTH WALES DISTRICT during the Year ended 31st of December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Underground.						On Surface.		
									Explosions.	Falls of Coal.	Falls of Stone.	Suffocation.	In Shafts.	Miscellaneous.	Machinery.	Miscellaneous.	Boilers bursting.
1868.																	
Jan. 1	1	Tondû	Bridgend	Brogden and Sons	Wm. Jones	Collier	24	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
" 2	2	Gadlys	Aberdare	Gadlys Iron Co.	Nichs. Price	Ditto	18	Ditto	–	–	1	–	–	–	–	–	–
" "	3	Glyncorrwg	Briton Ferry	Glyncorrwg Coal Co.	John Rees	Ditto	27	Killed by falling over tip	–	–	–	–	–	–	–	1	–
" 6	4	Cwmdare	Aberdare	Powell's Duffryn Steam Coal Company.	John Morris	Roadman	33	Killed by trams on engine plane	–	–	–	–	–	1	–	–	–
" 7	5	Gadlys	Ditto	Gadlys Iron Co.	Titus Lewis	Collier	33	Killed by a fall of coal	–	1	–	–	–	–	–	–	–
" "	6	Lower Duffryn	Ditto	P. D. S. Coal Co.	Peter Murphy	Ditto	26	Ditto	–	1	–	–	–	–	–	–	–
" 8	7	No. 9 Colliery	Ditto	Fothergill and Co.	Thomas Jones	Ditto	50	Ditto	–	1	–	–	–	–	–	–	–
" 16	8	Aberdare Merthyr.	Ditto	Aberdare Merthyr Steam Coal Co.	Wm. Jones	Ditto	27	Killed by trams	–	–	–	–	–	1	–	–	–
" "	9	Cethin	Merthyr Tydfil	R. T. Crawshay	Richd. Evans	Ditto	45	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
" 21	10	Dynevor	Neath	Dynevor Coal Co.	Wm. Jones	Ditto	15	Killed by trams on surface	–	–	–	–	–	–	–	1	–
" 23	11	Tila Coch	Pontypridd	Thomas Jones	David Thomas John Lewis	Ditto Ditto	35 28	Killed by an explosion of gas	2	–	–	–	–	–	–	–	–
Feb. 1	12	Broonbil	Taibach	Vivian and Sons	Watk. Jenkins	Haulier	17	Killed by trams	–	–	–	–	–	1	–	–	–
" 10	13	Lletty Shenkin	Aberdare	Lletty Shenkin Coal Co.	David John	Collier	48	Killed by a fall of roof	–	–	–	–	–	–	–	–	–
" 15	14	Slancainch	Cardiff	Duncan and Co.	Thos. George	Ditto	16	Killed by a fall of coal	–	1	–	–	–	–	–	–	–
" 17	15	Vochrin	Dowlais	Guest and Co.	Dd. Richards	Ditto	14	Ditto	–	1	–	–	–	–	–	–	–
" 19	16	Gellygwn	Pontypridd	John Priestley	John Pome	Ditto	27	Killed by a fall of stone	–	–	1	–	–	–	–	–	–
" 20	17	Middle Duffryn	Aberdare	P. D. S. Coal Co.	Job Evans	Ditto	47	Ditto	–	–	1	–	–	–	–	–	–
" "	18	Broadoak	Swansea	Broadoak Coal Co.	Jno. Thergun	Ditto	75	Killed by a fall of coal	–	1	–	–	–	–	–	–	–
" 26	19	Primrose	Ditto	Primrose Coal Co.	John Nathaniel	Ditto	49	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
Mar. 2	20	Wyndham	Bridgend	J. Brogden and Sons	Robt. Thomas	Labourer	29	Killed by a segment	–	–	–	–	–	–	–	1	–
" 3	21	Bryndowy	Neath	Neath Abbey Coal Co.	Jno. Edwards	Haulier	14	Killed by trams	–	–	–	–	–	1	–	–	–
" 4	22	Nantymain	Bridgend	J. Brogden and Sons	Jno. Evans	Collier	31	Killed by a fall of stone	–	–	1	–	–	–	–	–	–
								Carried forward	2	6	7	–	–	4	–	3	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Underground.						On Surface.		
									Explosions.	Falls of Coal.	Falls of Stone.	Suffocation.	In Shafts.	Miscellaneous.	Machinery.	Miscellaneous.	Boilers bursting.
1868.								Brought forward	2	6	7	–	–	4	–	3	–
Mar. 7	23	Rhedla	Glyn Neath	J. H. Morgan	J. Williams	Haulier	44	Killed by trams	–	–	–	–	–	1	–	–	–
„ 12	24	Worcester	Swansea	T. Glasbrook	J. Richards	Collier	23	Killed by an explosion. The deceased went past the danger signal with a naked light, fired the gas, and caused his death.	1	–	–	–	–	–	–	–	–
„ 16	25	River	Aberdare	Fothergill and Co.	Daniel Jones	Ditto	24	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
„ 21	26	Ferndale	Pontypridd	D. Davis and Sons	Jno. Beecher	Ditto	34	Ditto	–	–	1	–	–	–	–	–	–
„ 25	27	Oakwood	Bridgend	Wm. Davies	Jno. Morris	Ditto	18	Killed by trams	–	–	–	–	–	1	–	–	–
„ 26	28	Gellia Cadoxton	Neath	Evans and Bevan	Thos. Price	Ditto	—	Ditto	–	–	–	–	–	1	–	–	–
April 2	29	Tunnel	Aberdare	Fothergill and Co.	Wm. Jones	Collier	16	Killed by a fall of coal	–	1	–	–	–	–	–	–	–
„ „	30	Taibach	Merthyr Tydfil	Ditto	Essex Williams	Ditto	23	Ditto	–	1	–	–	–	–	–	–	–
„ 4	31	Abercwmboy	Aberdare	D. Davis and Sons	Jos. Quistel	Ditto	35	Ditto	–	1	–	–	–	–	–	–	–
„ 7	32	Castle	Merthyr Tydfil	R. T. Crawshay	Dd. Davies	Mason	40	Killed by falling from carriage whilst ascending the shaft.	–	–	–	–	1	–	–	–	–
„ 8	33	Aberdare	Aberdare	Aberdare Coal Co.	Jno. Price	Haulier	49	Killed by trams	–	–	–	–	–	1	–	–	–
„ „	34	Pwllfarvw	Glyn Neath	Neath Abbey Coal Co.	Wm. Rosser	Collier	70	Killed by trams on engine plane	–	–	–	–	–	1	–	–	–
„ 16	35	Cwmllynfell	Ystalyfera	James and Aubrey	Jonah Jones	Labourer	13	Ditto	–	–	–	–	–	1	–	–	–
„ 21	36	Navigation	Aberdare	Nixon and Co.	Ed. Hammer	Ditto	48	Killed by trucks on surface	–	–	–	–	–	–	–	1	–
„ 23	37	Oakwood	Bridgend	Wm. Davis	Thos. Hawkins	Sinker	33	Killed by rope breaking	–	–	–	–	1	–	–	–	–
„ „	38	Ferndale	Pontypridd	D. Davis and Sons	Hy. Josephs	Doorboy	13	Killed by trams	–	–	–	–	–	1	–	–	–
„ 24	39	Dynewl	Kidwelly	David Williams	Jonah Williams	Labourer	24	Killed by being struck by a windlass handle.	–	–	–	–	–	–	–	1	–
„ 29	40	Ferndale	Pontypridd	D. Davis and Sons	Hy. Jones	Doorboy	13	Killed by trams	–	–	–	–	–	1	–	–	–
May 1	41	Cwmcunan	Aberdare	H. Evans and Co.	Geo. Cotes	Doorboy	13	Killed at bottom of shaft	–	–	–	–	1	–	–	–	–
„ 2	42	California	Llanelly	Norton and Co.	Elias Watkins	Collier	42	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
								Carried forward	3	9	10	–	3	12	–	5	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Underground.						On Surface.		
									Explosions.	Falls of Coal.	Falls of Stone.	Suffocation.	In Shafts.	Miscellaneous.	Machinery.	Miscellaneous.	Boilers bursting.
1868.								Brought forward	3	9	10	–	3	12	–	5	–
May 6	43	Craig Cwm	Clydach	Geo. B. Strick	D. Davies	Collier	50	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
„ 8	44	Bryndu	Bridgend	Bryndu Coal Co.	T. Rogers	Haulier	14	Killed by trams	–	–	–	–	–	1	–	–	–
„ 13	45	Carnarvon	Loughor	Techon Coal Co.	Dd. Bevan	Collier	64	Killed by suffocation, the products of an explosion of gas.	–	–	–	4	–	–	–	–	–
					J. Hopkins	Ditto	24										
					T. Phillips	Ditto	27										
					T. Richards	Ditto	20										
„ 16	46	Cwmdu	Maesteg	J. Brogden and Sons	T. Jones	Ditto	34	Killed by an exploslon of gas	1	–	–	–	–	–	–	–	–
„ 21	47	Ferndale	Pontypridd	D. Davis and Sons	D. Davies	Ditto	38	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
„ „	48	Gadlys	Aberdare	Gadlys Iron Co.	Hy. John	Ditto	41	Ditto	–	–	1	–	–	–	–	–	–
„ 23	49	Tondû	Bridgend	J. Brogden and Sons	T. Howell	Ditto	23	Ditto	–	–	1	–	–	–	–	–	–
„ 26	50	Llynvi	Ditto	Llynvi Iron Co.	T. Richards	Ditto	58	Ditto	–	–	1	–	–	–	–	–	–
„ 27	51	Glinea	Llanelly	Sims, Willyams, Neville, and Co.	Evan Davies	Ditto	42	Killed by an explosion of gunpowder.	–	–	–	–	–	1	–	–	–
June 2	52	Glenwaindraeth	Llanelly	W. and D. Evans	J. Thomas	Collier	27	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
„ 13	53	Abergorkie	Pontypridd	Geo. Jusdle and Sons	Dd. Richards	Ditto	18	Ditto	–	–	1	–	–	–	–	–	–
„ 15	54	Hirwain	Aberdare	Hirwain Coal and Iron Company.	Jas. Undergrave	Labourer	35	Ditto	–	–	1	–	–	–	–	–	–
„ 18	55	Cwmdare	Aberdare	P. D. S. Coal Co.	Jno. Jones	Ditto	23	Killed by trams on engine plane	–	–	–	–	–	1	–	–	–
„ 19	56	Glyncoorwg	Bristow Ferry	Glyncorrwg Coal Co.	J. Lloyd	Collier	20	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
„ 29	57	Yneisfio	Pontypridd	Twedyrhiw Coal Co.	Jas. Evans	Door boy	14	Killed by trams	–	–	–	–	–	1	–	–	–
July 3	58	Gadbys	Aberdare	Gadbys Iron Company	Jas. Thomas	Collier	25	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
„ 9	59	Middle Duffryn	Ditto	P. D. S. Coal Co.	Jno. Davis	Door boy	13	Killed by trucks on surface	–	–	–	–	–	–	–	1	–
„ 10	60	Bryndowy	Neath	Neath Abbey Coal Co.	Thos. Jones	Haulier	27	Killed by a kick of a horse	–	–	–	–	–	1	–	–	–
„ „	61	Morfa	Taibach	Vivian and Sons	Isaac Kingdon	Hitcher	21	Killed by a tram at bottom of shaft	–	–	–	–	1	–	–	–	–
								Carried forward	4	9	20	4	4	17	–	6	–

List of Fatal Colliery Accidents—*continued*.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Underground.						On Surface.		
									Explosions.	Falls of Coal.	Falls of Stone.	Suffocation.	In Shafts.	Miscellaneous.	Machinery.	Miscellaneous.	Boilers bursting.
1868.								Brought forward	4	9	20	4	4	17	–	6	–
July 13	62	Garth	Bridgend	J. Brogden and Sons	Thos. Watkin	Collier	21	Killed by falling down shaft	–	–	–	–	1	–	–	–	–
„ 17	63	Pentrefellin	Swansea	Vivian and Sons	Thos. Morgan	Trammer	15	Killed by trams	–	–	–	–	–	1	–	–	–
Aug. 4	64	Lantwit Main	Llantrissant	Main Coal Co., Llantwit	T. Thomas	Collier	43	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
„ 4	65	Morfa	Taibach	Vivian and Sons	Lewis Watkin	Door boy	13	Killed by trams on engine plane	–	–	–	–	–	1	–	–	–
„ 10	66	Middle Duffryn	Aberdare	P. D. S. Coal Co.	J. Griffiths	Collier	14	Killed by trams	–	–	–	–	–	1	–	–	–
„ 21	67	Deep Duffryn	Ditto	Nixon, Taylor, and Co.	Calib Bray	Ditto	21	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
„ 21	68	Blaengwaur	Ditto	D. Davis and Sons	Roger Prosser	Door boy	11	Killed by a fall of roof, deceased was able to read and write.	–	–	1	–	–	–	–	–	–
„ 22	69	Glinea	Llanelly	Sims, Willyams, Neville, and Co.	Thos. Richards	Lander	51	Killed by falling down shaft	–	–	–	–	1	–	–	–	–
Sept. 4	70	Tynewydd	Bridgend	T. Thomas	Wm. Howells	Collier	20	Killed by a fall of stone	–	–	1	–	–	–	–	–	–
„ 16	71	Pwllfaron	Neath	Neath Abbey Coal Co.	T. Richards	Ditto	40	Killed by a fall of coal	–	1	–	–	–	–	–	–	–
„ 17	72	Hirwain	Aberdare	Hirwain Coal and Iron Co.	Za. Williams	Ditto	36	Ditto	–	1	–	–	–	–	–	–	–
„ 21	73	Pwllfaron	Neath	Neath Abbey Coal Co.	J. Jones	Ditto	44	Ditto	–	1	–	–	–	–	–	–	–
„ 26	74	Merthyr Dare	Aberdare	Rhys and Richards	W. Phillips	Haulier	23	Killed by trams	–	–	–	–	–	1	–	–	–
„ 28	75	Deep Duffryn	Ditto	Nixon, Taylor, and Co.	Fernham Sterry	Door boy	14	Ditto	–	–	–	–	–	1	–	–	–
„ „	76	Nantmelyn	Ditto	Mordecai Jones	Enoch Francis	Haulier	21	Ditto	–	–	–	–	–	1	–	–	–
Oct. 3	77	Lantwit	Llantrissant	T. Powell	T. Williams	Collier	29	Killed by a fall of roof	–	–	1	–	–	–	–	–	–
„ 5	78	Lower Duffryn	Aberdare	P. D. S. Coal Co.	J. Rees	Haulier	19	Killed by trams	–	–	–	–	–	1	–	–	–
„ 9	79	Llangennech	Llanelly	T. P. Margrave	Isaac Williams	Collier	32	Killed by trams on engine plane	–	–	–	–	–	1	–	–	–
„ 10	80	Cwmaman	Aberdare	H. Evans and Co.	Wm. Davies	Haulier	27	Killed by trams	–	–	–	–	–	1	–	–	–
„ 13	81	Park	Pontypridd	D. Davis and Co.	Rees Ellis	Collier	33	Killed by a fall of stone	–	–	1	–	–	–	–	–	–
								Carried forward	4	12	26	4	6	26	–	6	–

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Underground.						On Surface.		
									Explosions.	Falls of Coal.	Falls of Stone.	Suffocation.	In Shafts.	Miscellaneous.	Machinery.	Miscellaneous.	Boilers bursting.
1868.								Brought forward -	4	12	26	4	6	26	–	6	–
Oct. 14.	82	Lantwit -	Llantrissant -	T. Powell - -	Dd. Roderick -	Collier -	13	Killed by falling off carriage whilst descending shaft.	–	–	–	–	1	–	–	–	–
„ 21	83	Maine - -	Neath - -	Neath Abbey Coal Co. -	J. Lewis -	Ditto -	33	Killed by suffocation - -	–	–	–	1	–	–	–	–	–
„ 22	84	Lower Duffryn	Aberdare - -	P. D. S. Coal Co. -	J. Passmore -	Ditto -	29	Killed by trams on incline plane -	–	–	–	–	–	1	–	–	–
„ 23	85	Bute Merthyr -	Pontypridd -	Marquis of Bute - -	Jas. Cox -	Ditto -	35	Killed by a fall of stone - -	–	–	1	–	–	–	–	–	–
„ 31	86	Blanant -	Aberdare - -	Fothergill and Co. - -	Evan Evans -	Ditto -	28	Killed by a fall of roof - -	–	–	1	–	–	–	–	–	–
Nov. 12	87	Cwm Neol -	Aberdare -	P. D. S. Coal Co. -	Anthy. Griffiths	Collier -	17	Killed by a fall of roof - -	–	–	1	–	–	–	–	–	–
„ 14	88	Llynvi -	Bridgend -	Llynvi Iron Co. - -	Wm. Jenkins -	Haulier -	15	Killed by trams - - -	–	–	–	–	–	1	–	–	–
„ „	89	Bryndu -	Do. - -	Bryndu Coal Co. - -	Ll. Llandriggen	Ditto -	15	Ditto - - -	–	–	–	–	–	1	–	–	–
„ 28	90	Plymouth -	Merthyr Tydfil -	Fothergill and Co. -	Morgan Rees -	Collier -	13	Killed by a fall of roof - -	–	–	1	–	–	–	–	–	–
„ „	91	Broadoak -	Loughoo -	Broadoak Coal Co. -													
Dec. 5	92	Bargoed -	Dowlais - -	Guest and Co. - -	Thos. Thomas -	Collier -	12	Killed by trams on engine plane -	–	–	–	–	–	1	–	–	–
„ 8	93	Hirwain -	Aberdare -	Hirwain Coal and Iron Co.	Jas. Llewellyn -	Ditto -	12	Killed by trams on level - -	–	–	–	–	–	1	–	–	–
„ 16	94	Abergwaur -	Ditto - -	P. D. S. Coal Co. -	Lewis Davies -	Ditto -	25	Killed by a fall of stone - -	–	–	1	–	–	–	–	–	–
„ 22	95	Star - -	Kidwelly -	H. Pratt - -	Jno. Evans -	Ditto -	29	Ditto - - -	–	–	1	–	–	–	–	–	–
„ 23	96	Bargoed -	Dowlais - -	Guest and Co. - -	Jno. Davies -	Ditto -	12½	Killed by a fall of coal - -	–	1	–	–	–	–	–	–	–
„ 28	97	Merthyr Dare	Aberdare - -	Rhys and Richards -	Richd. Phillips -	Ditto -	28	Killed by a rope breaking, which was being used for raising old slides which were being replaced.	–	–	–	–	1	–	–	–	–
„ „	98	Lletty Shenkin	Ditto - -	Lletty Shenkin Coal Co. -	J. Richards -	Engineer	18	Killed by becoming entangled with the machinery.	–	–	–	–	–	–	1	–	–
„ 30	99	Vochriw -	Dowlais -	Guest and Co. - -	G. Jenkins -	Collier -	19	Killed by a fall of roof - -	–	–	1	–	–	–	–	–	–
„ „	100	Pantyffymon -	Llanelly - -	Dd. Lloyd and Son -	Morris Morris -	Ditto -	28	Ditto - - -	–	–	1	–	–	–	–	–	–
								Totals -	4	12	37	5	8	31	1	6	–

Mr. Moore's Report.

REPORT of the INSPECTOR of MINES and COLLIERIES in the EASTERN DISTRICT OF SCOTLAND, for the Year ended 31st December 1868.—By RALPH MOORE, Esq.

SIR, 7, Queen Square, Glasgow, 28th February 1869.

I HAVE the honour to submit my Annual Report as Inspector of Coal Mines for the Eastern District of Scotland.

The accompanying Schedules show that in the District during the year 1868.

In and about coal mines were lost, lives		43
The number of male persons employed was		29,000
The number of women working on the surface		683
The quantity of coal raised	Tons	8,456,084
The quantity of coal raised for every life lost		196,653
In 1867, the quantity ditto		131,622
The average ditto, England and Scotland 1868		103,429

In inspected ironstone mines one life was lost.

The tabulated results show that the loss of life last year was less than in 1867, and also that the quantity of coal raised for every life lost was above the average.

Falls of roof and coal are still the most frequent cause of deaths. In my former reports I have expressed an opinion that the deaths from these causes would be fewer if experienced men were employed to visit the men's working places at intervals during each shift, to set props, or at least to see that sufficient props are put up to the roof and coal. I am glad to state that a beginning has been made in two collieries in the Wishaw and Hamilton districts. These two collieries put out more than 300,000 tons of coal per annum. The managing partner of one of these collieries writes me, "I have "appointed a man to do nothing else but attend to the treeing and drawing of all wood "at the stooping, and I find we are getting a better class of men. We have never "seen any fire-damp, but we always keep them working with locked lamps at the "stooping."

There is not a great quantity of fire-damp in the "goaf" of the Wishaw and Hamilton coal fields, but I have more than once detected it, and the only death from explosion of fire-damp last year was caused, I had reason to believe, from a fall of roof, driving out some gas which was in the "goaf," upon the naked lights of some men working at pillars (stoops), one of whom was the deceased.

There were two steam-boiler explosions last year, one at Bo'ness, and the other at Motherwell. Both were high pressure boilers, 5 feet diameter, $\frac{3}{8}$ in. plates; the former was 20 years and the latter 15 years in use. It did not appear that either of them had been short of water, and, excepting the worn-out condition of the boilers, there was nothing to account for the explosions. A question arose out of the Bo'ness explosion as to compliance with the 13th general rule, which requires that *every* boiler shall be provided with a proper steam gauge. The boiler which exploded was one of a range of five boilers all connected together by one steam-pipe. A steam gauge was placed on this steam-pipe, and thus every boiler, when working, had a steam gauge, or was connected with a steam gauge; but the boiler had been "off" getting cleaned, and steam was being raised in it when it burst, so that it was not at the time provided or in connexion with a steam gauge; nor can any one of a range of boilers similarly situated, at all times comply with the general rule, unless there be a steam gauge upon each boiler.

At the suggestion of Crown Counsel I sent a circular to the coal masters in my district, requesting them to put a steam gauge on each boiler. Many of them have already complied, and others are doing so.

A breakage of a wire rope with a weight of 5 cwts., resulted in the loss of two lives. The rope was afterwards tested and bore a breaking strain of ten tons. The drum and pulley were only five feet diameter, which is rather small for wire ropes, but the working load was only 12 cwts., and it had only raised 8,000 tons. I could not account for the failure.

The shaft accidents are still high, and are doubtless in part owing to the increased number of shafts necessary for compliance with the statute.

I made investigations into all the fatal accidents; into such of the non-fatal accidents as seemed to call for investigation, and made examinations of other collieries where I had reason to think an examination was necessary.

I have taken every opportunity of examining such boys as came under my notice as to the educational provisions of the statute. The practice appears to be, not to allow any boy to enter the pit until he is 12 years of age. I have found boys under that age, but they could generally read and write, and I believe there are not many young boys go down the pits in this district, without being able to read and write a little. In scarcely an instance did the boys attend a night school. As a general rule boys get all the education they are likely to get before they enter the pit. There can be no doubt it would inflict a hardship on many a man, struggling to bring up a large family, to compel him to dispense with the services of his boy until he is twelve years of age, but there can be no doubt as to the benefit to the boy. Education at the colliery villages is both cheap and plentiful; there is abundance of good schools, with good teachers, convenient to the villages where the parents reside.

Last year there were 147 companies working coal in this district, some of them raising more than 400,000 tons of coal annually, and some of them less than 5,000 tons.

As the result of a careful estimate I find, that of the persons employed, every fifteenth person is employed in looking to the safety of the others, in the shape of manager, overman, deputy overman, fireman, and overlooker.

There are, therefore, in this district 2,000 persons employed by those companies to keep the pits safe for 29,683 persons engaged in and about mines, in working and conveying coal from the face until it is put into wagons at the surface.

Where the safety of the persons employed does not depend upon themselves, it depends upon these 2,000 persons, and the degree of safety which they afford depends upon the discipline and control exercised by the owners and principal agents, who alone have the control of this large staff. No important alteration can be made unless they sanction it; they propose the special rules, and can make application for their amendment at any time, and it is in their power, either by their own observation or by employing other skilled persons to do it for them, to see that the special rules are observed, and that proper discipline is maintained by the regular staff.

I have constantly urged this view of the duties of owners and principal agents, and especially of the benefit to be derived from close personal attention to the underground working arrangements. I believe that supervision would be most effectually done, where the owner himself does not personally exercise it, by a person not constantly employed in the colliery, but who would periodically visit it, and examine the working arrangements.

When we consider that year by year the pits in this district are becoming deeper, and consequently the machinery and arrangements increasing in magnitude, the decrease in the loss of life is creditable to the owners and managers of mines, and should stimulate them to persevere in making and adopting such arrangements as will lead to still better results. There can be no doubt that the adoption of the best means for increasing the safety and comfort of the workmen is true economy in a commercial point of view.

The last year was no improvement upon the preceding one as regards the coal trade. The prices of coal ranged very low; still owing to the opening up of new pits, and also owing to the men working more steadily, the quantity raised is in excess of 1867.

The opening up of new pits has kept up the demand for miners, and as a natural consequence wages have not been reduced. With the view of giving more information upon this subject than is generally known, I have got from some of the coal-masters the actual earnings of five colliers in their employment, which I believe to be a fair average of the district. The details are given below.

				£	s.	d.
No. 1.	Worked	229	days for	42	2	2
	Was idle	83				
No. 2.	Worked	253	" "	45	10	10
	Was idle	59				
No. 3.	Worked	265	" "	50	19	1½
	Was idle	47				
No. 4.	Worked	249	" "	62	6	2
	Was idle	63				
No. 5.	Worked	245	" "	53	16	0
	Was idle	67				

Annexed also is a chart showing the localities from whence the coals were raised, and where the accidents occurred.

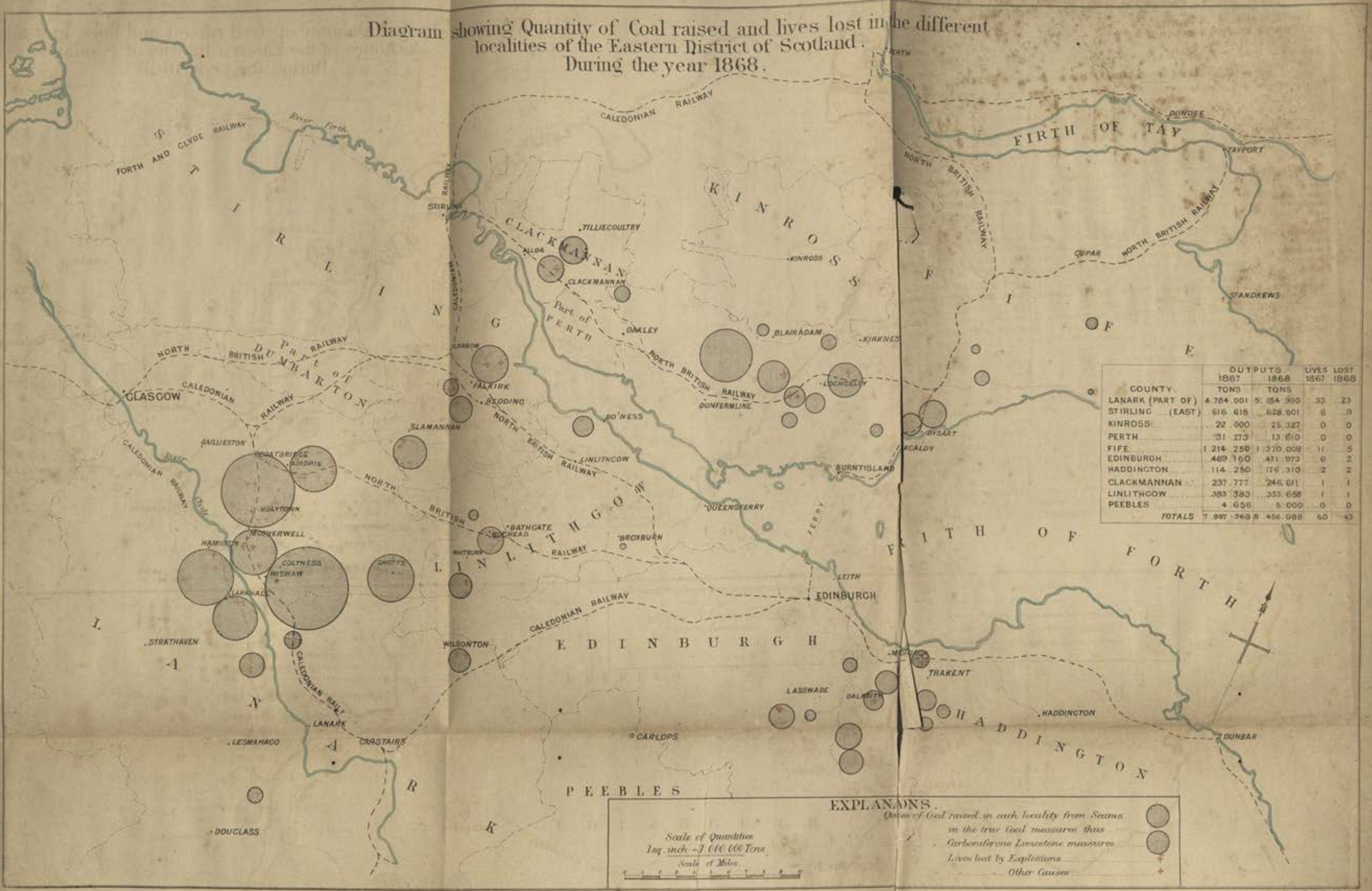
I have, &c.
(Signed) RALPH MOORE,
Inspector of Mines.

The Right Hon. H. A. Bruce, M.P.,
Her Majesty's Principal Secretary of State,
London.

Loss of Life, &c., in the Eastern District of Scotland during the Year 1868.

Name of County.	Lives lost.						Male Persons employed.	Quantity of Coal raised. —Tons.	Persons employed per Life lost.	Tons of Coal raised per Life lost.	Tons of Coal raised per Man employed.	Number of Women employed above ground.
	Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.						
Lanark - -	1	15	3	2	2	23	15,016	5,184,990	655	225,434	344	—
Stirling (East) - -	–	3	5	1	–	9	2,700	628,601	300	69,844	233	—
Kinross - -	–	–	–	–	–	–	90	25,327	—	—	281	—
Perth - - -	–	–	–	–	–	–	45	13,610	—	—	302	—
Fife - - -	–	5	–	–	–	5	4,614	1,370,008	923	274,001	297	—
Edinburgh - -	–	–	–	1	1	2	2,326	471,973	116	235,986	203	—
Haddington - - -	–	2	–	–	–	2	805	176,310	402	88,155	219	—
Clackmannan - -	–	–	1	–	–	1	863	246,611	1,121	246,611	232	—
Linlithgow - -	–	–	–	1	–	1	2,327	333,658	2,443	333,658	143	—
Peebles - -	–	–	–	–	–	–	14	5,000	—	—	337	—
Totals and Averages	1	25	9	5	3	43	29,000	8,456,088	692	196,653		683

Diagram showing Quantity of Coal raised and lives lost in the different localities of the Eastern District of Scotland. During the year 1868.


FIRTH OF TAY
DUNDEE
TAYPORT
PERTH
NORTH BRITISH RAILWAY
CALEDONIAN RAILWAY
FORTH AND CLYDE RAILWAY
River Forth
STIRLING
RAILWAY
CLACKMANNAN
TILLIECOULTRY
ALLOA
Part of PERTH
OAKLEY
KINROSS
BLAIRADAM
KIRKNESS
LOCHGELLY
DUNFERMLINE
CUPAR
ST ANDREWS
FIFE
DYSART
KIRKCALDY
BURNTISLAND
STIRLING
Part of DUMBARTON
GLASGOW
CARRON
FALKIRK
REDDING
SLAMANNAN
BO'NESS
LINLITHGOW
BAILLIESTON
COATBRIDGE
AIRDRIE
HOLYTOWN
MOTHERWELL
HAMILTON
COLTNESS
WISHAW
LARKHALL
SHOTTS
BATHGATE
BOGHEAD
WHITBURN
BROXBURN
QUEENSFERRY
FERRY
FIRTH OF FORTH
LEITH
EDINBURGH
WILSONTON
MUSSELBURGH
TRANENT
LASSWADE
DALKEITH
HADDINGTON
DUNBAR
CARLOPS
PEEBLES
STRATHAVEN
LANARK
LESMAHAGO
CARSTAIRS
DOUGLASS
River Clyde
EXPLANATIONS.
Quantities of Coal raised in each locality from Seams in the true Coal measures thus
Carboniferous Limestone measures
Lives lost by Explosions
Other Causes
Scale of Quantities 1sq. inch = 1 000 000 Tons
Scale of Miles
0 1 2 3 4 5 6 7 8 9 10

COUNTY	OUTPUTS 1867	OUTPUTS 1868	LIVES LOST 1867	LIVES LOST 1868
	TONS	TONS		
LANARK (PART OF)	4.784.001	5.184.990	33	23
STIRLING (EAST)	616.618	628.601	6	9
KINROSS	22.000	25.327	0	0
PERTH	31.273	13.610	0	0
FIFE	1.214.250	1.370.008	11	5
EDINBURGH	489.160	471.973	6	2
HADDINGTON	114.250	176.310	2	2
CLACKMANNAN	237.777	246.611	1	1
LINLITHGOW	383.383	333.658	1	1
PEEBLES	4.656	5.000	0	0
TOTALS	7.897.368	8.456.088	60	43

EASTERN DISTRICT OF SCOTLAND.

COLLIERS ANNUAL EARNINGS, YEAR 1868.

LANARKSHIRE.

No. of Fortnight.	Days worked.	Earnings. £	s.	d.	Remarks. Cause of Idleness.
1	–	–		–	Pit idle.
2	11	1	14	10	Miners' meeting.
3	10	1	13	5	
4	10	1	12	7	
5	10	1	12	1	
6	9	1	9	5	
7	9	1	9	6	
8	8	1	6	11	Miners' meetings.
9	8	1	9	2	
10	9	1	10	4	
11	10	1	14	0	
12	10	1	14	9	
13	8	1	17	1	
14	9	1	15	2	
15	9	1	18	9	
16	10	2	5	3	
17	10	2	4	10	
18	9	1	14	11	
19	6	1	5	11	
20	5	1	1	2	
21	9	1	15	7	
22	6	0	19	9	
23	10	1	16	5	
24	11	2	2	0	
25	12	2	0	6	
26	11	1	17	10	
	229	42	2	2	

FIFESHIRE.

No. of Fortnight.	Days worked.	Earnings. £	s.	d.	Remarks. Cause of Idleness.
1	7½	3	2	6	
2	10	4	2	3	
3	9	3	2	7	
4	10	3	14	2	
5	8½	3	0	5	
6	11	4	0	10	
7	10	3	19	10	
8	10	4	11	11	
9	10	3	5	8	
10	7½	2	8	2	
11	9	2	18	7	
12	10	3	12	6	
13	10½	4	2	6	
14	10	3	12	6	
15	8½	2	6	9	
16	11	3	13	6	
17	11	4	11	1	
18	10	3	8	9	
19	9½	3	11	3	
20	10¼	3	5	6	
21	9½	3	3	10	
22	9½	3	2	6	
23	11	3	7	11	
24	9½	3	2	0	
25	10	3	16	9	
26	10¼	3	17	6	
	253¼	91	1	9	

THE LOTHIANS.

No. of Fortnight.	Days worked.	Earnings. £	s.	d.	Remarks. Cause of Idleness.
1	9	2	4	11	Sometimes owing to repairs on engines and boilers the water is not out, and the men are thrown idle for a day or two at the most. Generally, however, the cause of idleness is attributable to the collier himself.
2	9½	2	3	8	
3	10	2	0	11	
4	9½	2	0	8	
5	10	1	18	1	
6	11	2	2	9	
7	11	2	0	9½	
8	8	1	10	4	
9	10	1	14	2	
10	11	2	0	2	
11	10½	1	15	5	
12	9	1	15	6	
13	11	2	5	0	
14	10	1	18	3	
15	10	1	14	11	
16	12	2	4	0	
17	9	1	14	0	
18	10	1	16	10	
19	9½	1	12	0	
20	11½	1	17	1	
21	10	1	15	5	
22	10½	1	19	7	
23	11	2	8	10	
24	10	1	17	10	
25	10	2	1	0	
26	12	2	7	0	
	265	50	19	1½	

LANARKSHIRE, HAMILTON.

No. of Fortnight.	Days worked.	Earnings. £	s.	d.	Remarks. Cause of Idleness.
1	7	1	12	9	5 days holidays.
2	10	1	18	3	2 attending meetings.
3	10	1	17	4	2 ,,
4	10	1	13	8	2 ,,
5	11	3	7	6	1 ,,
6	10	2	6	11	2 ,,
7	3	0	11	4	9 pit standing.
8	5	0	19	0	7 ,,
9	11	2	2	9	1 attending meeting.
10	9	1	14	2	3 pit standing.
11	11	2	2	9	1 attending meeting.
12	11	2	10	10	1 ,,
13	10	2	10	10	2 ,,
14	10	2	8	7	2 ,,
15	10	2	15	8	2 ,,
16	10	2	7	3	2 ,,
17	7	2	9	6	2 ,, and 3 holidays.
18	10	3	2	2	2 attending meeting.
19	11	2	14	11	1 ,,
20	10	2	13	3	2 ,,
21	10	2	13	0	2 ,,
22	11	3	12	2	1 ,,
23	9	2	12	8	1 ,,
24	12	3	7	9	
25	12	3	11	4	
26	9	2	9	10	1 attending meeting.
	249	62	6	2	

LANARKSHIRE, WISHAW.

No. of Fortnight.	Days worked.	Earnings. £	s.	d.	Remarks. Cause of Idleness.
1	6	1	6	0	Holidays.
2	8	1	12	7	Miners' meetings.
3	8	1	8	7	
4	10	2	1	5	
5	9	2	0	5	
6	11	2	3	8	
7	12	2	13	10	
8	7	1	5	3	Miners' strike.
9	11	2	12	7	Miners' meetings.
10	10	2	3	9	
11	12	2	14	8	
12	8	1	17	3	Bad health.
13	11	2	0	0	
14	11	2	9	7	Miners' meetings.
15	8	1	15	3	
16	11	2	4	11	
17	10	2	2	9	
18	8	1	18	7	Unwell.
19	7	1	11	11	,,
20	7	1	12	4	,,
21	10	2	3	10	Miners' meetings.
22	11	2	15	4	
23	11	2	10	3	
24	7	1	8	9	
25	12	3	2	10	
26	9	1	19	8	
	245	53	16	0	

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS OF LIFE arising therefrom, in the EASTERN DISTRICT of SCOTLAND, during the Year ended 31st December 1868.

Date.	No. of Accident.	Name of Colliery.	Where situate.	Owners' or Agents' Names.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives Lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868. Jan. 15	1	Balquhatstone	Slamannan	John Watson	Robert Paterson	Miner	35	While he was ascending the pit, the pinion wheel of the engine broke and the descending cage being heaviest, he was carried to the pulleys, and fell back into the pit. Brake on fly wheel.	–	–	1	–	–	1
Feb. 7	2	Hill of Beath	Dunfermline	Ord. Adams	Rob. Campbell	Brusher	24	Failing to take down a side piece of sandstone shaken by a *shot*, it fell over upon him.	–	1	–	–	–	1
" 8	3	Stanrigg	Falkirk	Alexr. Wilson	Wm. Bennie	Collier	23	He was supposed to have fallen at a broken step, while descending traps to the bottom of a 40-fathom pit.	–	–	1	–	–	1
Mar. 2	4	Greenfield	Hamilton	Hamilton Coal Co.	Wm. M'Innis	Ditto	23	He was underholing, and four tons of coal rolled over on him. The seam was four feet high.	–	1	–	–	–	1
" "	5	Blackbraes	Falkirk	James Russel and Son	James Weir	- - -	55	- - - - - -	–	1	–	–	–	1
" 12	6	Carnbroe No. 8	Holytown	Merry and Cunninghame	R. Montagu	Collier	31	He was underholing the lower leaf of a 3 feet coal under 3 feet of the upper leaf, which fell upon him. He lived three days afterwards.	–	1	–	–	–	1
" 17	7	Darngavil No. 5	Airdrie	Pat. Rankin	B. Montagu	Drawer	13	He worked with his father and brother, and was passing along the face when the roof fell on him. Seam 3 feet; roof sandstone.	–	1	–	–	–	1
" 19	8	Capeldrae	Lochgelly	Robert Aytoun	Wm. Munro	Collier	23	He was working under a mass of top coal, which fell upon him. Seam 6 feet thick, in two leaves.	–	1	–	–	–	1
								Carried forward	–	6	2	–	–	8

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owners' or Agents' Names.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
								Brought forward -	–	6	2	–	–	8
1868. Apr. 7	9	Parkhead -	Motherwell -	John Watson -	— Hamgan -	Collier -	—	Burned by an explosion of gas from the goaf. Six men were burned. He died some weeks afterwards.	1	–	–	–	–	1
" 11	10	Commonhead -	Airdrie -	Colville and Gray -	Jas. M'Dermot -	Ditto -	40	Was underholing, when a blade of sandstone 6 inches thick, 8 feet by 7 feet, fell on him. Seam 30 inches. Roof sandstone. Overman warned him to put up props.	–	1	–	–	–	1
" 16	11	Airdriehill -	Ditto -	Jas. Black and Son -	Jno. Rankine -	Brusher -	22	He was building the roadside when a stone fell out of the roof by a lipe upon him. Seam 4 feet. Roof sandstone.	–	1	–	–	–	1
" 20	12	Easter Glentore	Ditto -	Robert Hunter -	Dd. Hunter -	Manager -	40	Fall of sand and gravel in a mine near the surface. Mine not properly wooded.	–	–	–	–	1	1
" 21	13	Grangemouth -	Falkirk -	Grangemouth Coal Co. -	W. Chalmers -	Brusher -	36	He was preparing to blast down the roof, twelve feet back from the face, when it fell upon him Seam 3 feet. Roof shale.	–	1	–	–	–	1
May 1	14	Muirhouse -	Wishaw -	Archd. Russel -	Jno. Yuil -	Driver -	11	This boy was passing along with a train of tubs when the roof fell upon him.	–	–	–	1	–	1
" 13	15	Greenhill -	Holytown -	Robert Young -	Pat. Cairney -	Collier -	25	A piece of top coal weighing half a ton fell upon him. The seam is 8 feet thick in two leaves, the first leaf was 4 feet in advance, and he was working at it.	–	1	–	–	–	1
" 14	16	Lumphinans -	Lochgelly -	Lumphinans Iron Company	W. Brown -	Ditto -	43	Fall of roof by a lipe. The seam was 30 inches. Roof a seam of coal 6 feet thick.	–	1	–	–	–	1
								Carried forward -	1	11	2	1	1	16

List of Fatal Accidents in Coal Mines—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost. Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.								Brought forward	1	11	2	1	1	16
May 21	17	Bells Dyke	Airdrie	Dundas Simpson	Sam. Morton	Collier	26	Fall of roof (sandstone) while taking out pillars. Seam 4 feet.	—	1	—	—	—	1
June 6	18	Mossend	Holytown	Mossend Iron Co.	R. Bennie	Drawer	15	Fall of roof at pit-bottom. Not properly supported.	—	1	—	—	—	1
„ 18	19	Whitehill	Airdrie	Henderson and Dimmack	A. Sommerville	Overman	—	Crushed by cage at pit-bottom when stepping on.	—	—	—	1	—	1
July 15	20	Skellyton	Larkhall	Hamilton and M'Culloch	A. Fleming	Driver	—	Hutch got off rails, and knocked out a prop, and roof fell upon him.	—	1	—	—	—	1
„ 25	21	Ditto	Ditto	Ditto	J. Loudon	Overman	40	Was leaning over pit mouth at low scaffold, when the cage came down, and knocked him into the pit.	—	—	1	—	—	1
Aug. 3	22	Stonecrags Coltness.	Wishaw	Coltness Iron Co.	Jas. Thomson	Collier	20	Fall of roof (coal). Seam 9 feet high.	—	1	—	—	—	1
„ 6	23	Limerigg	Slamannan	Robert Baird	Thos. Maxwell	Sinker	—	Struck on head by the plumb-bob (about 4 lbs.) falling off the end of the line. He died 10 days afterwards.	—	—	1	—	—	1
„ 10	24	Stevenston	-	Stevenston Coal Co.	Jas. Clark	Collier	40	Fall of coal of side of a stoop while taking out pillars. Coal 3 feet thick. Roof sandstone.	—	1	—	—	—	1
Sept. 16	25	Lochgelly (Raith)	Lochgelly	Lochgelly Iron Co.	Will. M'Caig	Ditto	50	These men were sitting at breakfast about 20 feet back from the face of their room, when the roof (about 12 inches of coal) fell suddenly upon them.	—	1	—	—	—	1
					Jno. Yeats	Ditto	52		—	1	—	—	—	1
„ 23	26	Carron	Falkirk	Carron Iron Co.	W. Wilson	Driver	12	Fell when running between his horse and a race of tubs, and the hutches ran over him.	—	—	—	1	—	1
								Carried forward	1	18	4	3	1	27

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost in Coal Mines.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868.								Brought forward	1	18	4	3	1	27
Oct. 2	27	Dalkeith	Dalkeith	Duke of Buccleuch	— Hope	Engineman	70.	He stepped on the connecting rod when the engine was in motion, and got his foot jammed between it and the wall. This man had worked the same engine for 30 years, and it is said had frequently been so reckless as to do what at last cost him his life.	–	–	–	–	1	1
Oct. 9	28	Orbiston	Bell's Hill	Mossend Iron Co.	D. Hanigan	Sinker	31	He was working in the bottom of this sinking pit, and something fell down and struck him on the head.	–	–	1	–	–	1
„ 12	29	Parkhead	Motherwell	John Watson	Robert Wilson	Manager	52	Explosion of a steam boiler	–	–	–	–	1	1
„ 24	30	Whitehill	Dalkeith	Archd. Hood	D. Dubie	Pony driver	15	Run over by tubs	–	–	–	1	–	1
„ „	31	Prestongrange	Prestonpans	Sir George Suttie	R. Sneddon	Collier	60	He was underholing, and the coal rolled over upon him. Seam 52 inches worked longwall.	–	1	–	–	–	1
„ 28	32	Binniehill	Slamannan	John Watson	J. McEwan	Ditto	22	Roof fell on him while holing. Coal 26 inches thick; roof sandstone. Worked by longwall.	–	1	–	–	–	1
„ 30	33	Blackbraes	Falkirk	Jas. Russel and Son	J. Chalmers	Ditto	35	They were descending the pit to examine something at the bottom, when the rope (a round wire) broke.	–	–	1	–	–	1
					John Sneddon	Ditto	22		–	–	1	–	–	1
Nov. 11	34	Cleugh	Wilsontown	Wm. Darling's Trustees	Jas. Watson	Ditto	30	He worked in a place out of hearing of neighbours; some stones fell on him so that he could not extricate himself, and he lay (not much injured) for 24 hours till relieved. Died from exposure next day.	–	1	–	–	–	1
								Carried forward	1	21	7	4	3	36

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost. Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868.								Brought forward	1	21	7	4	3	36
Nov. 12	35	Haywood	Wilsontown	Haywood Coal Co.	M. Steel	Overman	45	Fall of roof while knocking out props.	–	1	–	–	–	1
„ 13	36	Prestongrange	Prestonpans	Sir George Suttie	Thos. Archibald	Drawer	14	The roof fell on him while pushing his tub out main road.	–	1	–	–	–	1
„ „	37	Benhar	Linlithgow	George Simpson	A. Hailstones	Ditto	14	Knocked against a prop by collision with another drawer, injured internally, and died next day.	–	–	–	1	–	1
Dec. 2	38	Tennochside	Coatbridge	Monkland Iron Co.	D. Hannan	Sinker	23	He was struck by a stone which fell off side of pit.	–	–	1	–	–	1
„ 5	39	Stepends	Airdrie*	Summerlee Iron Co.	J. Parkes	Collier	43	Was holing his coal, when stone fell from roof. Seam 30 inches; roof sandstone. Worked longwall.	–	1	–	–	–	1
„ 22	40	Sheardale	Clackmannan	James Wingate	J. Wingate	Manager	27	He was descending a pit on a crane rope, the end of which was insufficiently attached (by himself) to the barrel. It surged, and he fell off.	–	–	1	–	–	1
„ 30	41	Riggside	Douglas	James Swann	A. Wilson	Miner	40	A piece of stone fell off wall side and killed him.	–	1	–	–	–	1
									1	25	9	5	3	43

List of Fatal Accidents and Loss of Life in Ironstone Mines.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
Sept. 23	42	Polkemmet	Bathgate	Sholla Iron Company	Jas. O'Brien	Labourer	31	Fell in among machinery, taking a "short cut" to the pithead from the engine house.	–	–	–	–	1	–

Mr. Alexander's Report.

REPORT upon the INSPECTION of MINES in the WESTERN DISTRICT of SCOTLAND, for the Year ended 31st December 1868.—By WILLIAM ALEXANDER, Esq.

SIR, Glasgow, February 27, 1869.

I HAVE the honour to lay before you my Thirteenth Annual Report upon the mines and collieries in the west of Scotland.

In preparing these periodical statements the labour would be of a more agreeable kind if the information requiring to be submitted referred only to the extension of works, the modes of exhaustion practised, and the changes and improvements which are from time to time being introduced into the various mineral fields. Each succeeding year, however, brings round its painful record of fatalities, slightly varied in detail, but always showing forcibly to what extent the everyday life of those who toil in mines is beset with dangers over which, in many cases, they have little or no control. The consideration, therefore, of loss of life, and how to prevent it, must always take a prominent place in the reports of an inspector.

Notwithstanding the many painful occurrences which for the year now ended have to be deplored, it must be a subject of thankfulness, that while saddening disasters have ravaged busy centres of industry in other localities, no extensive or wide spread calamity has taken place among the collieries of this district.

For the past year the number of collieries in operation has been 203. The persons employed in and about them were 21,160, and I estimate the total produce of coal and dross at 6,253,875 tons.

The fatal accidents connected with these works were 40, causing the loss of a like number of lives. Of these, 18 were married men, whose untimely death left 18 widows and 28 fatherless children unprovided for, 15 were single or unmarried, and 7 were boys.

The accompanying Schedule No. I. will briefly explain in what way these unfortunate occurrences took place, and the following is an abstract of it.

Year.	Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous and above ground.	Total loss of Life.
1868	4	20	7	9	40

PROPORTION of Lives lost to the Number of Persons employed and the Tons of Coal raised.

Persons employed.	Quantity of Coal produced.	Lives lost.	Persons employed per Life lost.	Tons of Coal raised per Life lost.	Loss of Life per Million Tons of Coal raised.
21,160	6,253,875	40	529	156,346	6·3

Though the number of fatal accidents for the past year has been slightly in excess of 1867, it is still under the general average, and compares with former years favourably.

The loss of lives from explosions of fire-damp were four, and of these at least three happened through recklessness and neglect. The quantity of gas causing the accident in each case was trifling, and with one exception the sufferers survived their injuries for some days after. I have nothing new to suggest as to the prevention of such accidents, it is vexatious to think that they should have occurred at all, and I can only repeat the observations made in former reports, that a more stringent observance of the special rules would prevent the recurrence of all such distressing events. One of the most important precautions in connexion with this branch of mine management, is to carry out a systematic examination of the working places every morning before the workmen are allowed to enter them ; and I find that the best way to do this is to provide that the engineman shall not allow the descent of workmen into the colliery on any morning till after the fireman has made his underground examination, and has signalled to the surface to that effect. With this precaution, however, there is still the difficulty of proving or knowing that the fireman has faithfully performed his duty ; and in some cases of non-fatal explosions which I have had occasion to investigate, reasonable doubts have been entertained as to the truthfulness of the fireman's report that an examination was made at all. It would narrow the likelihood of such an omission, and form a satisfactory check, if an additional rule was introduced, compelling the fireman each morning to leave his mark, or the date of examination with chalk, on the face of the coal in every working place.

The accidents from falls of coal and roof, exactly 50 per cent. of the whole, are rather under the average of bygone years, and, with two exceptions, they happened to the sufferers while working at the coal face or while engaged taking down part of the roof and securing it. The duty devolves entirely upon the workmen to protect themselves from falls of roof within a given distance of the face of their working places, and a decrease in this class of accidents may fairly be attributed to greater care on their part. The immunity from casualties of this description appears to be much greater in mines where the "longwall system" is practised; and though more than a half of the coal has been raised by *that method*, for the period to which this report refers, 80 per cent. of the fatal accidents from falls of coal and roof happened in mines worked by the "stoop and room" system.

In shafts the accidents are also under the average of former years. Three fell away from the cage or kettle on which they were being lowered or raised; two fell from the surface; one was thrown off a scaffold while making repairs in the shaft; and another by mistake pushed a hutch into the wrong division of the shaft, and fell to the bottom with it. It is discouraging year after year to have to call attention to loss of life in the way last described; and if a general rule were introduced, enforcing the use of self-acting guards or wickets at *all pits* where coals are put out, this description of accident would forthwith cease to be heard of.

The fatal accidents miscellaneous and above ground have been unusually numerous and much in excess of the average of past years. They do not come under any general head, but exhibit strikingly the many ways in which accidents happen to persons employed in and about mines. One was kicked by a horse ; two got entangled with pumping machinery ; one fell a few feet from a scaffold on the surface ; two were run over by loaded hutches ; one was crushed under machinery while assisting to load it into a railway waggon ; and two were burnt and bruised by gunpowder while blasting.

In ironstone mines of the coal measures, and worked in connexion with coal or with any disused or exhausted coal mine, the fatal accidents were four. Of these, two were occasioned by falls of roof ; one by the breakage of a crane rope ; and one by a stroke from his "pinch" or lever, which slipped while he was using it to force off a piece of ironstone at the face of his place. Though the majority of the ironstone mines do not come within the scope of the Mines Inspection Act, the accidents which occur in them are nearly every one reported to me, either by the owners of the mines or the Crown Agent. I examine into and report as to the cause of accident in nearly every case, but it is only those which come under the statute that are entered in Schedule No. 2.

The accidents of a non-fatal kind which have been reported from every description of mine were 237.

Explosions of fire-damp - - - - -	80
Falls of coal, ironstone, and roof - - -	112
In shafts - - - - - -	16
From miscellaneous causes and above ground -	29

Comparing them with those of a fatal kind they are nearly six times more numerous, and in glancing over the long list it is cheerless to think of the distress and protracted suffering which must in many instances have resulted from them.

Improvement in the working details of the collieries generally, though not accompanied by a marked diminution of loss of life, is gradually advancing, and the mines of 1868 are unquestionably superior in point of management and skilful appliances to those of 20 years ago. The standard of good management is not, strictly speaking, to be measured by the amount of loss of life, for it is a well-known fact that the greatest number of accidents do not always happen in the *worst* managed mines. There is something connected with underground labour incompatible with safety; and we have it from undoubted statistics that a certain number of lives will be lost annually, ranging from five to ten, for every million tons of coal raised. What the *real* amount of risk is, independent of recklessness on the part of the sufferers or neglect on the part of the management, will probably vary in different mineral fields, but I believe that it will be a long time before the fatalities in the mines of this country will average fewer than five or six for every million tons of coal raised; and in the most favourable situations, and with the greatest care, not less than four. There is another point of view, however, and perhaps a more cheering one, from which to measure the progress of improvements as affecting life, and that is to consider whether the average age at which persons continue to labour in mines has not been extended.

I cannot adduce evidence of a satisfactory kind, but I am of opinion that it has been lengthened, and in support of this I refer to Schedule No. 1, which shows that from a sixth to a seventh of the fatal accidents which took place in 1868, happened to persons while labouring in and about mines whose ages averaged 64, and ranged from 60 to 69 years.

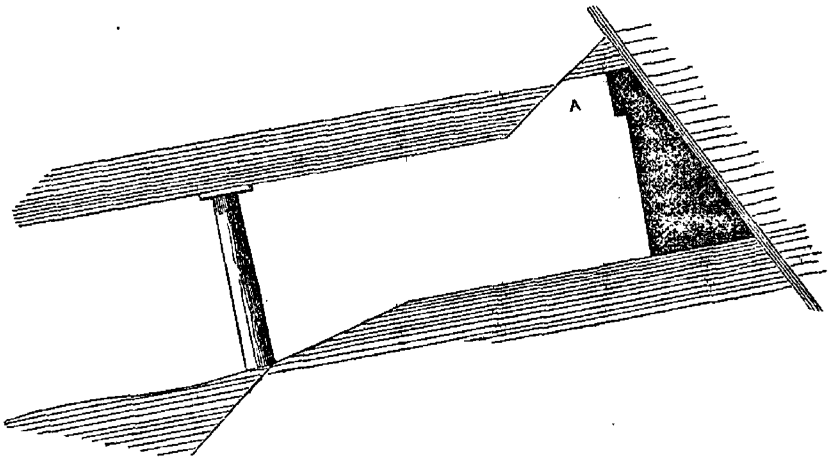
The duration of the coalfield, and how to economize it, has now become a subject of interest, and as old leases expire more stringent regulations are introduced into new ones, principally relating to the modes of working, and, occasionally, the *order* in which the seams are to be worked. The matter is entirely in the hands of the proprietors of lands and their advisers, and probably it would tend to systematise arrangements if some recognized and judicious system were strongly recommended, which, without interfering with private rights, would have a tendency to check or guard against any unnecessary waste of this invaluable source of national wealth. The modes of working coal are " stoop and room " and " longwall." The former admits of endless variety of procedure; in some cases pillars of coal are formed with the view of being afterwards taken out, wholly or in part, and in other cases the tenant is held bound to leave a given proportion of the coal for the purpose of maintaining the roof and surface; but by the latter, while there may be slight variations in the mode of extraction, still the important result is in nearly all cases the same, the *whole* of the coal is obtained, and in the best marketable state. The more stringent regulations referred to consist mainly in defining that certain seams shall be worked by " longwall," or that a system of forming pillars at first working shall be carried out, so as to give a reasonable security that they shall be afterwards worked away, or, if temporarily abandoned, *not lost*. Apparently there are few seams so situated as to prevent the introduction of the " longwall " method; and in practice I find that this judicious system is carried out in every description of seam, and under an endless variety of conditions. It is a lucky circumstance in this case that the mode of working best adapted for economizing the seams of coal is also the safest in so far as relates to falls of coal and roof, that constant source of accidents in all mines; and it is important to know that though upwards of a half of the coal got in this district during the past year was by the longwall system, only 20 per cent. of the lives lost by falls of coal and roof took place in such mines. These unfortunate occurrences go on without intermission, and seem very little affected by the means hitherto adopted to prevent them, but if by changing the system of working a greater immunity from accidents could be obtained for the persons who work in mines, and a more complete exhaustion of the coalfield carried out, then the subject is well deserving of attention, and ought to enlist the interest of both the economical and humane.

At times when unusual disasters occur in mines much sympathy is manifested for the sufferers among all classes throughout the country, and the question of how best to relieve them in such cases has of late been attracting the attention of the sympathising and kind. It would be a great achievement if some well-devised scheme of universal application could be introduced, calculated to alleviate such awful calamities, and partially lighten the gloom thrust so suddenly on many a bereaved home; and probably the most practical and least objectionable would be a general system of insurance to which every underground workman should be compelled to contribute, supplemented by public and private contributions from the owners of mineral estates, colliery owners, and gentlemen of wealth and influence, so comprehensive as to assist the disabled and to provide for the widows, the fatherless, and orphans of all who may lose their lives while engaged in or exposed to the risks and dangers of the mine.

Though there is not much occasion for special remark upon any of the accidents which happened, it may be useful to detail a few of the more prominent cases, and explain the peculiar circumstances under which they took place.

Accident No. 2. *was occasioned by an explosion of fire-damp.*

The deceased, who was a collier, had been engaged on the morning of the accident for three hours or thereby in his working place, and worked with an open or unprotected light. The place he was extending was near to a dislocation two fathoms down, and he had just driven through a small hitch of 18 inches up, a few feet back from the face. As to how the accident occurred, it appears that the deceased had gone out with his "drawer," a boy, to assist him a short distance with a loaded hutch, and on returning to his place, ignited a little gas which had collected during the few minutes he was absent. A very small part of the "head coal," A, as per sketch, inside of the 18-inch hitch, had been taken down shortly before the accident, and the gas which was ignited had apparently gathered in that small opening.



Accident No. 4. *was occasioned by the deceased getting entangled with the underground machinery.*

There is a small engine situated near to the bottom of this pit, and the steam used by it is produced on the surface. The deceased was an assistant engineman. At the time of the accident he was engaged on the night shift, when the surface and underground engines were engaged pumping water. The steam being produced on the surface, the underground engine, when once started to pump water, did not require constant attention further than keeping it moving at the speed required to raise the drainage of the dook. It was the duty of the deceased to visit the underground machinery occasionally, perhaps five or six times during the night, and he was lowered and raised by the winding machinery. Some time before the accident it appears that he had been lowered to the bottom of the pit in the usual way. The engineman, his neighbour, observing that he remained unusually long, went down a "stair" pit to learn the cause of delay, and on reaching the machinery found him lying crushed between the fly-wheel and a cutting formed in the pavement, in which the lower part of the fly-wheel revolved. It is supposed that the deceased had, after being lowered to the bottom of the pit, proceeded down the dook to examine the state of the water in it. His lamp was found about mid-way down, and it is presumed that it had fallen or the light gone out, and in afterwards approaching the machinery without a light, he had unexpectedly got entangled with it. The deceased was 68 years of age, and though he was considered competent, it would have been more satisfactory if a younger person had been appointed to perform the duties.

Accident No. 10. *was occasioned by the deceased falling out of the cage while being raised.*

The deceased at the time of the accident was being raised on the cage, along with other three workmen, and when about mid-shaft he fell from it suddenly to the bottom of the pit, a distance of 42 fathoms. I learned afterwards that the unfortunate sufferer had been subject to convulsive attacks, and it is supposed that he had been seized by one at the time the accident happened. It would be prudent I think to prevent such persons from going into mines unless under special regulations.

Accident No. 16. *was occasioned by an explosion of fire-damp.*

According to the special rules of the colliery, it was the duty of the fireman to descend the pit before the colliers shift commenced, and to proceed through every drawing road and along the whole coal-faces and working places in the colliery, and minutely examine the same, &c. It appears that the fireman did descend the shaft on the morning of the accident, and, as the pit was not expected to be worked fully for the day, according to his own statement, he examined only two or three of the working places. He afterwards had occasion to go with the deceased, who was to assist him to make some changes in one of the usual working places, but which had not been examined, and ignited a quantity of fire-damp, by which the deceased was severely burned and died from the effects of it.

The fireman in this case was charged by the Procurator Fiscal of Ayr with culpable homicide, as also culpable neglect of duty; he was tried by the sheriff and a jury, when he pled guilty to culpable neglect of duty, and was sentenced to four months imprisonment.

Accident No. 17. was occasioned by the deceased attempting to leap off the cage after it was raised a little above the usual landing.

In this case, the cage had been lifted a little higher than the usual landing when men were being raised, and the deceased, who was on it along with two neighbouring workmen, leaped off while it was in motion, and on to the platform at the pit-head, where unfortunately he overbalanced and fell back into the shaft. The other workmen remained upon the cage, and got off it safely a few feet higher up.

There was something unsatisfactory and irregular with regard to the signals, and though a bottomer was employed to see the hutches placed carefully upon the cage, and to make the necessary signals, he had frequently allowed the workmen to make the signals themselves. The engineman excused himself by saying that only one signal had been made, and in consequence thereof, less caution was observed than if he had been aware that men were being raised upon the cage.

Accident No. 21. was occasioned by the upsetting of a piece of machinery while loading it into a railway waggon.

The deceased was the foreman engineer at the colliery; he was engaged with others at the time of the accident loading some machinery into a railway waggon, when a crank weighing about six cwts., suspended by a crane rope, canted suddenly while being lowered, and the deceased was crushed under it.

Accident No. 24. was occasioned by the deceased falling from a scaffold while engaged repairing the guide rods in the shaft.

It appears that the "guide rods," or wooden conductors, in the shaft had got displaced by the guides upon the cage getting out of place. The deceased and two others, the oversman being one of them, had been engaged for 12 or 14 hours before the accident happened making the necessary repairs upon the shaft, and for that purpose a scaffold was suspended by chains from the bottom of the cage, and hanging about 20 feet below it, for them to stand upon. With the exception of their tools, there was no other weight upon the scaffold except two guide rods, the one 18 and the other 9 feet in length. I understand that the 18 feet length rested upon the scaffold at one end, and was lashed to one of the chains about 8 feet above the level of the scaffold. The accident was occasioned by the scaffold breaking or giving way right along the centre.

The oversman and his neighbour kept their places, or rather held on by the sides of the scaffold, and after great exertions reached the cage by climbing up the "buntons," but the deceased fell from the scaffold to the bottom, a distance of 80 yards. The construction of the scaffold was faulty, and since the accident, cross bars of iron have been added for the purpose of strengthening it.

There was some uncertainty as to the real cause of accident. I was of opinion that it had been occasioned by the guide rod 18 feet long, above referred to, getting displaced or hanging out at the top, and when the cage was raised, such as was being done when the accident happened, it came in contact with the midwall, and forced the scaffold asunder.

Accident No. 26. was occasioned by an explosion of fire-damp.

The deceased, who was the general manager, had on the day of the accident gone in company with the fireman to examine a block of coal near to the pit bottom, with the view of advising as to the mode of working it out. There was an air-course near to it, and as they had occasion frequently to go into the place it was not considered necessary to use the precaution of making an examination with a safety lamp before entering it, and they used open lights. In the course of their examination they ignited a small quantity of gas at a " cutter." The space where they had to travel in was contracted; the fireman made his way out and escaped, but the deceased unfortunately got affected by the gases and combustion, and was left behind. The flame from the cutter communicated with the dry wood, coal, and other loose materials in that part of the mine, not more than 80 or 100 yards from the pit bottom, and though repeated attempts were made to reach the deceased, they proved unsuccessful, and as a last resource the shafts and outlets were closed. Trivial though the matter appeared to be at first, it was some weeks after before the fire was subdued, and when an exploration was made, what was supposed to be the charred remains of the deceased were found not more than 60 yards from the pit bottom. Apparently he had got stupefied or confused by the sudden rush of flame in the contracted course and missed his way.

Accident No. 32. was occasioned by the deceased getting entangled with the crank of the pumping engine.

The deceased was engaged as an assistant engineman. It appears that on the night of the accident he had gone to his work in the usual way, there was no one along with him at the time, and about half an hour after he had entered upon his shift he was found lying crushed under the crank of the engine. It was imagined that he had been working about the valve of the " feed pump," when by some overlook on his part his dress had got entangled with the crank of the engine, and he was drawn round with it and crushed against the sides of the recess formed in the floor, in which the crank revolved.

Accident No. 35. was occasioned by the deceased pushing a hutch into the wrong division of the shaft and falling to the bottom with it.

In this case the deceased was an assistant pit headman, he had been to the " bing" with a hutch of coals, and on returning with the empty hutch instead of putting it on to the cage to be returned in the ordinary way, he pushed it into the wrong division of the shaft, and fell to the bottom with it. Such accidents occur, I believe, through a kind of forgetfulness or momentary absence, and happen to experienced workmen. There is no way of preventing them but by introducing moveable guards at the pit-mouth, which form a perfect protection when the cage is not there.

Accident No. 36. was occasioned by an explosion of fire-damp.

It appears that a stone mine had been in the course of extension for a considerable time, but for a day or two previous to the accident it had been discontinued on account of an excess of gas. The roadway leading into deceased's place passed by the end of the stone mine. It seems to have been well known to him, and those who worked in the same limited district with him, that fire-damp existed in the mine, and that it had been partially stopped until an opening, a small " blind pit," could be put down upon the end of it to form a better circuit for the air. Notwithstanding, the deceased went into within a few feet of the face of the mine with an open light, and ignited the gas, by which he was burned; at first, it was not supposed to be seriously, but he died from the effects of it about a week after. It is difficult to know whether in this case a fence would have prevented the accident. By the second general rule it was the duty of the owner to use such a precaution, but he failed to do so.

I have, &c.,
(Signed) William Alexander,
Inspector of Mines.

To the Right. Hon. H. A. Bruce, M.P.,
Principal Secretary of State,
London.

SCHEDULE No. 1.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS of LIFE arising therefrom, in the WESTERN DISTRICT of SCOTLAND, during the Year ended 31st December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868. Jan. 6	1	Barleith, No. 4 Pit	Kilmarnock	John Galloway and Co.	Adam Irving	Pony driver	15	By a kick from the pony he was driving.	–	–	–	1	–	1
„ 8	2	Summerlee, No. 3	Coatbridge	Wilsons and Co.	John Hamilton	Collier	60	Explosion of fire-damp	1	–	–	–	–	1
„ 14	3	Provanhall, No. 5	Baillieston	Provanhall Coal Company	Robert Paterson	Drawer	16	Fall of roof on main drawing road	–	1	–	–	–	1
Feb. 10	4	Bannockburn	Bannockburn	Mrs. Geddes	Alexander Stevenson	Assistant engineman.	68	Got entangled with the underground machinery.	–	–	–	1	–	1
„ „	5	Newton	Cambuslang	J. P. Kidston	Richard Sneddon	Manager	62	By falling a few feet off a scaffold at the pit head.	–	–	–	–	1	1
„ 14	6	Grougar, No. 3	Galston	Portland Iron Company	John Cowan	Boy	13	Fall of stone at face	–	1	–	–	–	1
„ 15	7	Drumpeller, No. 2	Coatbridge	Wilsons and Co.	William Eccles	Miner	40	Fall of roof while forming a lodgment off a sinking pit.	–	1	–	–	–	1
„ 26	8	Neilston, No. 1	Kilsyth	James Wallace and Co.	Joseph Jarvie	Collier	40	Fall of coal at face	–	1	–	–	–	1
„ 28	9	Bredisholm, No. 4	Baillieston	Charles Tennant and Co.	William Frame	Boy	15	Fall of roof at face while engaged undermining.	–	1	–	–	–	1
Mar. 1	10	Govan, No. 3	Glasgow	W. S. Dixon	Archd. Maxwell	Collier	19	Fell out of the cage while being raised.	–	–	1	–	–	1
„ 7	11	Kilwinning, No. 2	Kilwinning	Eglinton Iron Company	Thomas Elliot	Boy	15	Fall of roof about 10 faths. from the face.	–	1	–	–	–	1
„ 9	12	Kirkwood, No. 2	Coatbridge	John Hendrie	Thos. Mackie	Drawer	23	Was run over by a loaded hutch	–	–	–	1	–	1
„ 17	13	Neilston, No. 1	Kilsyth	James Wallace and Co.	David Shaw	Collier	12	Fall of roof at face	–	1	–	–	–	1
„ 30	14	Drumpark, No. 1	Baillieston	Drumpark Coal Company	James Weir	Drawer	14	Fall of coal at face	–	1	–	–	–	1
April 7	15	Hillhead, No. 2	Airdrie	William Baird and Co.	Pat Fowley	Collier	18	Explosion of gunpowder	–	–	–	1	–	1
„ 8	16	Armsheugh	Irvine	Merry and Cunningham	James Holdon	Ditto	45	Explosion of fire-damp	1	–	–	–	–	1
„ 29	17	Meiklehill	Kirkintilloch	James Gairdner	George McKay	Ditto	22	Fall of roof while repairing a roadway.	–	1	–	–	–	1
								Carried forward	2	9	1	4	1	17

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.								Brought forward	2	9	1	4	1	17
May 5	18	Bartonholm, No. 2	Kilwinning	Eglinton Iron Company	John Johnston	Collier	23	Fell down the shaft when attempting to leap off the cage after it was raised a little above the usual level.	—	—	1	—	—	1
„ 18	19	Hurlford, No. 12	Hurlford	Allan Gilmour and Co.	James Turnbull	Ditto	24	Fall of coal when in the act of taking it down.	—	1	—	—	—	1
„ 25	20	Stottencleugh Mine	Muirkirk	Eglinton Iron Company	Wm. McWhirter	Boy	14	Injured by a hutch upon a drawing road, and died a few days after.	—	—	—	1	—	1
June 2	21	Kilgramie	Girvan	Joseph Whitefield	Hugh Croally	Collier	60	Fall of coal and roof	—	1	—	—	—	1
„ „	22	Canobie	Canobie	Duke of Buccleuch	James Forrat	Foreman engineer.	42	Was crushed while loading machinery into a railway waggon.	—	—	—	—	1	1
„ 16	23	Bogleshole, No. 4	Tollcross	James Dunlop and Co.	Pat. Newman	Brusher	23	While engaged blasting with gunpowder.	—	—	—	1	—	1
„ „	24	Espieside, No. 3	Coatbridge	Wm. Baird and Co.	James Easton	Collier	37	Fall of coal, died a week after the accident.	—	1	—	—	—	1
„ 27	25	Redan	Stevenson	Merry and Cunningham	Frank Mullen	Ditto	30	Fall from a scaffold while repairing the guide rods in the shaft.	—	—	1	—	—	1
July 1	26	Cairnhill, No. 5	Airdrie	Wm. Baird and Co.	R. Hamilton	Sinker	32	Fell off the kettle while being raised in the shaft.	—	—	1	—	—	1
„ 14	27	Strone	Kilsyth	Richard Brown	Alex. Lorimer	Manager	36	Explosion of fire-damp	1	—	—	—	—	1
„ 16	28	Espieside, No. 5	Coatbridge	Wm. Baird and Co.	Nicol Stewart	Collier	30	Fall of roof	—	1	—	—	—	1
„ „	29	Common	Cumnock	William Walker	James Park	Ditto	48	Fall of roof at face	—	1	—	—	—	1
Aug. 24	30	Dalquharran	Maybole	T. F. Kennedy	Thos. McClusky	Sinker	44	Fell from a kettle whilst descending the shaft.	—	—	1	—	—	1
„ 29	31	Byrehill	Kilwinning	Eglinton Iron Company	Robt. Perrie	Collier	69	Fall of coal at face	—	1	—	—	—	1
„ „	32	Auldhouseburn	Muirkirk	George Vallance	Wm. Stevenson	Ditto	67	Fall of coal while engaged taking it down.	—	1	—	—	—	1
Sept. 14	33	North Boig	N. Cumnock	Lanemark Coal Company	Adam Dickie	Engineman	23	Found crushed under the crank of the pumping shaft.	—	—	—	—	1	1
								Carried forward	3	16	5	6	3	33

List of Fatal Colliery Accidents—*continued*.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868.								Brought forward	3	16	5	6	3	33
Sept. 22	34	Dalharco, No. 2	Dalmellington	Dalmellington Iron Co.	James Dickson	Brusher	28	Fall of roof while engaged taking it down.	–	1	–	–	–	1
Oct. 19	35	Opencast, No. 2	Coatbridge	Wm. Baird and Co.	George Clarkson	Collier	48	Fall of coal at face	–	1	–	–	–	1
Nov. 6	36	Portland, No. 5	Hurlford	Eglinton Iron Company	Alex. McDonald	Hillman	54	Fell down the shaft by pushing a hutch into the wrong division of it.	–	–	1	–	–	1
„ 16	37	Neilston, No. 2	Kilsyth	James Wallace and Co.	James Britton	Collier	19	Explosion of fire-damp	1	–	–	–	–	1
Dec. 3	38	Wellwood	Muirkirk	Eglinton Iron Company	Hugh McLachlan	Ditto	45	Fall of coal at the face	–	1	–	–	–	1
„ 9	39	Neilston, No. 2	Kilsyth	James Wallace and Co.	Thos. McKay	Ditto	30	Fall of roof at the face	–	1	–	–	–	1
„ 28	40	Solesgirth	Kirkintilloch	Ditto	Jas. Gilmour	Pitheadman	16	Fell down a (sinking) pit	–	–	1	–	–	1
									4	20	7	6	3	40

SCHEDULE No. 2.

LIST of the FATAL ACCIDENTS in IRONSTONE MINES, and LOSS OF LIFE arising therefrom, in the WESTERN DISTRICT of SCOTLAND, during the Year ended 31st December 1868.

Date.	No. of Accidents.	Name of Mine.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost in Ironstone Mines.					
									Explosions.	Falls of Ironstone and Roof.	In Shafts.	Miscellaneous.	Above ground.	Total.
1868. Feb. 28	1	Riskend - -	Kilsyth -	W. Baird and Co. -	Peter Quin -	Miner -	36	Fall of roof at face - -	–	1	–	–	–	1
May 20	2	Barriston -	Campsie -	Wishaw Iron Company -	Thos. Paterson -	Ditto -	20	Fall of ironstone - - -	–	1	–	–	–	1
July 24	3	Faskine, No. 8 -	Airdrie -	W. Baird and Co. -	Wm. Ashwood -	Ditto -	58	Was struck by his "pinch," which slipped while he was forcing off a piece of ironstone at the face.	–	–	–	1	–	1
Oct. 10	4	Gartshore, No. 3	Kilsyth -	Ditto - - -	James Collins -	Drawer -	36	Fell from the cage by the crane rope falling upon him.	–	–	1	–	–	1
									–	2	1	1	–	4

Mr. Southern's Report.

REPORT on the INSPECTION OF MINES in the NORTHUMBERLAND, NORTH DURHAM, and CUMBERLAND DISTRICT, from the 31st December 1867 to the 31st December 1868.—By GEORGE WILLIAM SOUTHERN, Esq.

SIR, Newcastle-on-Tyne, February 27, 1869.

I HAVE the honour, as Inspector of Mines for the Northumberland, North Durham, and Cumberland inspection district, to transmit to you the following, as my Report with reference to the operation of the Mining Inspection Act during the year ending 31st December 1868.

Appended to this, my annual Report, is a detailed list of fatal colliery accidents, that have occurred in the district during the year, and which I am happy to say shows a decrease (although small) of four in the number of separate accidents, and also a decrease of 12 in the number of deaths resulting therefrom, as compared with the former year.

As will be seen by the list alluded to, the causes and numbers of accidents and deaths have been:—

—	Separate Accidents.	Number killed.	Total, separate Accidents.	Total Deaths.
From				
Explosions of fire-damp	3	3	—	—
Falls of Coal and Stone.				
Falls of coal	4	4	—	—
Do. of stone	24	26	—	—
In Shafts.				
Over-winding	—	—	—	—
Ropes or chains breaking	1	1	—	—
Whilst ascending or descending	7	7	—	—
Falling into shaft from top	2	2	—	—
Falling from part way down	3	3	—	—
Things falling down shafts	3	3	—	—
Sundries in shafts	—	—	—	—
Miscellaneous Underground.				
Explosions of gunpowder	—	—	—	—
Suffocation by gas	1	1	—	—
Irruption of water	—	—	—	—
Falling into water	—	—	—	—
On incline and engine planes	2	2	—	—
By				
Trams or tubs underground	10	10	—	—
Machinery underground	—	—	—	—
Sundries underground	1	1	—	—
			61	63
On Surface.				
Machinery	—	—	—	—
Boilers bursting	—	—	—	—
Sundries	6	6	6	6
Total			67	69

The above table shows that the number of accidents and deaths resulting from explosion of gas is not more than three, which from the fiery nature of a large portion of the district is a circumstance affording me very much pleasure in reporting, particularly when it is considered, that during the last few months of the year, the state of the barometer was very variable, a condition of things tending from experience to show a more than ordinary liability to accidents of that nature.

The number of accidents and deaths from falls of coal and roof, is a little below the average.

The shaft accidents are high in number, and of a more miscellaneous character than those of last year.

The accidents which have occurred on incline planes, and by trams and tubs, are much below the average, and have resulted mainly from carelessness or fool-hardiness on the part of the sufferers themselves. The accidents on the surface, during the year, have also, I am happy to say, not been numerous.

The total number of accidents last year in this district has been 67, and of deaths 69; and for the previous year 71 accidents, and 81 deaths.

Explosion of Gas.

From this cause three deaths have been occasioned during the year, and from three separate accidents; the first, No. 14 on the list, was caused by the overman of the Asby Colliery imprudently going into a place not in use, with a naked light, and there being explosive gas present it was ignited and caused his death.

The second, No. 19 on the list, was caused by a small blower of gas coming off at a gullet in the roof, in the workings of the North Seaton Colliery, from which there had been an outburst of water, on the subsidence of which gas was given off, and unfortunately a hewer working in an adjoining place, through curiosity, went shortly after the gullet or fissure had been pricked, to see it, and placing his candle close to the break fired the gas, and although not seriously burnt, as was supposed at the time, was sufficiently so, with exposure to the air afterwards, as to cause his death. The quantity of air in this mine is altogether 110,000 cubic feet per minute; and of this there was 15,000 cubic feet per minute, going into the way in which the accident occurred, it being afterwards split into nearly equal portions, so that about 7,000 cubic feet per minute were used for ventilating the particular part of the workings where it happened.

The third, No. 34 on the list, occurred at Ouston Colliery, to a deputy-overman, who had gone into an old board to seek a sleeper, for the purpose of putting it in a working place, when, a fall of the roof having previously taken place, explosive gas had lodged in the cavity formed by the fall, and was ignited by his light, thereby causing his death.

Falls of Coal and Stone.

Accident No. 23 on the list, occurred to Elisha Whitehouse, who was killed by a fall of stone at Cramlington Colliery.

From the evidence of a hewer, who worked in a place adjoining that in which the deceased was employed, it appeared that he had been in the place where the accident happened, about an hour before the occurrence, and noticed a slip in the roof, and thought a trouble was being approached; he said there was plenty of props in the place ready for use, for their safety. Shortly before the accident a shot had been fired to blast some coal down, but which was not immediately effective, and it was supposed that on the deceased returning to the face (from which he had necessarily retired during the firing of the shot) the coal had fallen, and, owing to the slip named in the roof, a portion of stone fell along with it, and which, falling upon Whitehouse, caused his death.

The fatal accident No. 26 occurred at the bank head of an incline plane in the West Sleekburn, one of the Bedlington Collieries, and caused the death of two boys employed there. At the inquest, George Morgan, a hewer, stated in evidence, that he had for some time previously passed under the stone twice a day, and observed nothing wrong; that when it had fallen it showed a slip in the roof, causing the stone to be what is called a horse-back. Thomas Croudace, the under viewer of the colliery, stated that the place was, up to the time of the accident, in a similar position to what it had been for 10 or 12 years previously, and that he had last seen it eight days before the occurrence, when he saw nothing amiss; but, from inquiry, I found that the planks or crown trees had been placed longitudinally, and which, although considered sufficient for that place, I advised that, for the future, they should, in places similarly situated to that where the accident happened, be placed the reverse way, or at a right angle to the direction of the slip, in order to prevent the chance of their being canted, as in this instance; and which he promised should be attended to.

Accident No. 31 took place at Usworth Colliery. The evidence showed that a deputy had been in the working place a short time before the occurrence, and timbered it up, as near the face as he could get it; but, in the course of working the coal, the deceased had subsequently bared the roof sufficiently to cause a fall of stone, which had come away suddenly at a slip in the strata.

Accident No. 40 occurred at North Seaton Colliery, from a fall of what is called following stone, a portion of the roof which is separated from the over-lying strata by a parting, this parting being in some cases so clear as to cause the following stone to fall with the coal, when the latter is excavated, or to be easily taken down by the workmen afterwards; when this is not so, then it is secured by propping. The district of the mine in which this accident occurred having a roof of this nature, it necessarily happens that much is left for their safety in respect of it to the workmen themselves; and it was shown in evidence, at the inquest, that every precaution had been taken by the officials of the colliery, to have the working places carefully propped, and to provide timber to be set where necessary, during the absence of the deputy, and also that the hewers were frequently warned to use the necessary precautions.

Accident No. 60 occurred in the Maudlin seam at Usworth Colliery, and was occasioned by the deceased, Hugh McCann, going into a place other than that in which he had been, at the commencement of his shift, set to work, for the purpose of getting a few coals to complete his day's work, and where he thought he would obtain them more readily than in his own working place; but unfortunately by removing the coal the roof fell and killed him.

Suffocation by Gases.

One fatal accident has occurred in my district during the past year from this cause, and it happened on the 3d August, at the Lintz Colliery near Burnopfield, to a hewer named James O'Neil. On notice being received of the occurrence, and at the request of some of the workmen, I examined the state of the mine and the ventilation, previous to the adjourned inquest. The ventilation being in my opinion not sufficient for the general requirements, and considering it my duty to report the same to the Secretary of State and the owners of the colliery, I wrote as follows:—

" SIR, Newcastle-on-Tyne, 15th August 1868.

" I HAVE the honour to report that on the 5th instant I made an inspection of " the workings of the Lintz Colliery, near Burnopfield, my attention having been par- " ticularly directed to that colliery in consequence of a collier having died in a part " of the workings, on the 3d instant, his death being supposed to have been caused by " the imperfect ventilation of the mine, and from a wish expressed in a letter received " from some of the workmen that I should inspect the workings. The result of my " examination of the state of the ventilation, &c., is, that I have considered it my " duty to give the owners of the colliery a notice, of which the following is a copy.

" I have the honour to remain, Sir,
" Your most obedient servant,
(Signed) GEO. WM. SOUTHERN.

" To the Right Hon. Gathorne Hardy, M.P.,
" Secretary of State,
" Whitehall.

" To the Owners of Lintz Colliery, near Burnopfield.

" GENTLEMEN, Newcastle-on-Tyne, August 15, 1868.

" I REGRET to have to give you notice, that on my inspection of the workings of " your mines, on the 5th instant, and to which my attention was more particularly " directed in consequence of the death of one of your workmen, named James O'Neil, " and which, according to the verdict of the jury at the adjourned inquest, on the " 7th instant, was said to be from his inhaling, in your mine, noxious gases, I found " the ventilation in some parts scarcely sufficient to comply with the 1st general rule of " the Mine Inspection Act, 23 & 24 Vict. c. 151, and in the cross-cut way of the Busty " Bank seam, not sufficient.

" And I trust, for the safety of your workmen, some means will be immediately " used; in the first place to increase the quantity of air in the mine; and secondly, to " keep a current of air to the face of the workings, where the miners are at work, so " that the 1st general rule, before named, may be fully complied with.

" I have the honour to remain, Gentlemen,
" Your obedient servant,
" GEO. WM. SOUTHERN,
" Inspector of Mines."

I found on a subsequent visit to the colliery that an improvement had taken place, and I have reason to believe that still further improvement is in progress, for its better ventilation.

In Shafts.

Accident No. 3 in the general list occurred at Usworth Colliery, to Andrew Johnson, a hewer, who was killed by being crushed between the cage and guides in the shaft, the cage having been set in motion by the brakesman whilst the deceased was getting in. The evidence given showed the signal arrangements to be as perfect as they could be made, but a misunderstanding had evidently occurred, through the on-setter, William Oliver, having supposed that the movement of the cage was under his control, and, in consequence, allowing the men to get into it; whereas the banksman expected that he was at liberty to signal the brakesman to draw it away, at the time, without a signal from the on-setter. The blame, if any, appeared to be on the part of the on-setter, but at the inquest the jury did not think culpable negligence had been displayed, and returned a verdict of "accidental death."

Accident No. 28 was occasioned, at Seghill Colliery, by a bolt from one of the cages, whilst at the top of the pit, having become disengaged, and falling to the bottom, when it unfortunately caught the assistant on-setter on the head, and caused his death. The engineer of the colliery suggested a different arrangement of such bolts, which would prevent the recurrence of a similar accident.

Accident No. 41 happened at the Eden Pit, Consett Collieries. The waiter-on at the top of an underground staple, whilst performing his duties, was in the act of putting a tub into the cage, as he expected; but the cage, instead of being at the top of the staple, as he supposed, was at the bottom; and the consequence was that he fell with the tub into the shaft or staple, and was killed. A candle was the only light kept at this place, and, not much work being done there, it was supposed to be sufficient for the purpose; but at the inquest the jury recommended that in future an oil lamp or other improved light should be used. I also suggested that a gate, to be worked by the cage, should be erected: both of which the viewer of the colliery said should be attended to.

Accident No. 52 occurred at Beamish Colliery, from the breaking of one of the pit ropes, whilst a horsekeeper was descending the shaft. Although no satisfactory evidence could be obtained at the inquest, it appeared evident that by some unaccountable means, almost immediately the cage was started, the rope had dropped off the pulley, and falling on the shaft of the same, there broke, precipitating the cage with its occupant to the bottom of the pit.

The rope, which was manufactured by Messrs. Newall and Co., of Gateshead, had been in use about three months, and appeared to be of very good quality.

After the accident, for the purpose of testing it, Mr. Spencer, Messrs. Newall's agent, had a portion of it cut from the broken end, and tried in a testing machine at Messrs. Abbot's works, at Gateshead, where it then bore, from my own observation, six times the working load to which it had been put, and about ten times as much as that it was subjected to at the time of the occurrence.

Neither at the inquest, nor on my inspection of the place and inquiries made, could anything satisfactory be ascertained as to the cause of the rope having been thrown off the pulley (supposing such to have been the case), and that it had been so there seemed to have been little or no doubt.

Accident No. 64 occurred at Walbottle Colliery, to a poor boy who had that day been employed to drive a pony from a flat on the inbye side to the top of a staple where the coals are let down from the main coal seam to the splint seam, a depth of about 14½ fathoms. He did not require, in the performance of his duties, to come on the flat sheets, which are of iron, and placed at the top of the staple; and from the evidence at the inquest it appeared that he had been particulary warned that morning by the rolley-way man, under whose charge he was, not to come so near the staple top as the flat sheets; and what caused the rolley-way man to be more particular in charging him was, that he saw that the deceased had clogs on his feet, which, being shod with iron, made him more liable to slip on the metal plates should he inadvertently come on them. Had gates been in use at this staple, doubtless the accident would not have occurred, or at any rate would not have been fatal; and, as in a case referred to in this report, I advised the immediate adoption of the same, which the officials of the colliery promised should be done.

I would here remark that it is very important to have self-acting gates at the top of all underground staples, and I take every opportunity of urging the necessity of their being used.

Miscellaneous Underground.

Accident No. 53 occurred at Mickley Colliery, to a boy named Robert Gair, a trapper at that colliery. He, poor boy, had left the door, of which he had charge, and followed an empty set of tubs drawn by a horse, and which had just passed through his door, to a flat on the inbye side (a very common practice, although contrary to rules, but the temptation to do so is great in order to relieve the monotony of their employment of opening and shutting the door, and being quite apart from other boys), and after spending a little time there, set off to reach his door before the arrival of a set of full tubs which were about to start; immediately on his starting, a hewer, named Joshua Rutter, in coming outbye was passing the set, and leaping on the first tub, persisted in having the whip from the driver in charge, with which he flogged the horse into an unusually quick pace; the poor boy running in front had it is presumed through this lost his light which he carried, and his progress being retarded in consequence (if he could have escaped even with his light in), was run down by the horse, and then was crushed by the tubs.

The evidence went to show that Rutter had opportunity of knowing and probably did know that the boy Gair was going before the set, but was regardless of consequences.

It was also adduced that the special rules provided that no one was allowed to ride on the tubs, but in practice they had not been prevented; yet there was a special order that no one on any account was to ride on the first tub of the set, this being for the purpose of preventing interference with the duties of the driver.

At the inquest the verdict of the jury was one of "manslaughter" against Joshua Rutter, (and in my opinion a very proper one,) on which he was committed by the coroner for trial at the assizes.

The other fatal cases of a miscellaneous nature underground were in some instances caused by carelessness on the part of the deceased themselves, and in others were of a purely accidental nature.

Miscellaneous on Surface.

The fatal accidents under this head have been, with only one exception, cases of being run over by wagons, and all of the ordinary sort.

Boilers Bursting.

From this cause, I am happy to say, there has been no fatal accident during the past year.

Non-fatal Accidents.

There have been during the year 57 non-fatal accidents reported. Of these there occurred,—

From explosion of gas	11
" fall of stone	15
" fall of coal	2
" tubs	10
" explosion of powder	5
" shafts	2
" miscellaneous underground	6
" " on surface	6
	57

The number of non-fatal accidents from explosions of gas which have occurred, point to the urgent necessity of introducing safety lamps in place of naked lights, where there is the least apprehension of danger from explosive gas, and of keeping the brattices (where required to be used) in the working places as near the face as practicable; and those from falls of stone and coal to the need of extreme care on the part of both officials and workmen, to see that every provision is made to secure the roof, by having a sufficiency of timber, and of using it where necessary.

Slips or partings in the roof cause very many accidents; they often exist in roofs otherwise good, and too much caution cannot be exercised as to the propping of a place whenever they make their appearance.

I have, &c.
(Signed) GEO. WM. SOUTHERN,
Inspector of Mines.

To the Right Hon. H. Austin Bruce, M.P.,
Her Majesty's Principal Secretary of State,
Whitehall, London.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS of LIFE arising therefrom, in the NORTHUMBERLAND and NORTH DURHAM and CUMBERLAND DISTRICT, during the Year ending 31st December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost in Coal Mines.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868.														
Jan. 2	1	Melgramfitz	Near Workington	I. Fletcher & Co.	Thomas Halliday	Hewer	33	Getting out of cage whilst in motion	–	–	1	–	–	1
„ 6	2	Togstone	Near Acklington	Isa Smith	Thomas Thompson	Sinker	18	Fell down shaft	–	–	1	–	–	1
„ 13	3	Usworth	Near Gateshead	Geo. Elliot & Co.	Andrew Johnson	Hewer	37	Crushed between cage and slide	–	–	1	–	–	1
Feb. 1	4	Ditto	Ditto	Ditto	John Tyson	Engineman	21	Fell down shaft	–	–	1	–	–	1
„ 14	5	Tanfield Lea	Ditto	Jas. Joicey & Co.	George Brown	Putter	14	Crushed between tub and plank	–	–	–	1	–	1
„ 16	6	Pelaw Main	Near Chester-le-Street.	Hunt, Perkins, & Co.	Henry Bulmer	Hewer	22	Fall of stone	–	1	–	–	–	1
„ 23	7	Burradon	Near Newcastle	J. Bower & Co.	Joseph Duxfield	Banksman	54	Fell off cradle in shaft	–	–	1	–	–	1
Mar. 23	8	St. Hilda	Nr. South Shields	Wood, Blackett, & Co.	John Oliver	Pony putter	15	Crushed by tubs	–	–	–	1	–	1
April 4	9	Blacksyke	Near Milton, Carlisle.	M. Thompson & Sons	George Todd	Hewer	36	Fall of stone	–	1	–	–	–	1
„ 7	10	West Pelton	Near Chester-le-Street.	Jas. Joicey & Co.	John Harrison	Driver	14	Crushed by tubs	–	–	–	1	–	1
„ 13	11	Backworth	Near Newcastle	Lamb, Taylor, & Co.	John Craig	Guard	22	Run over by wagons	–	–	–	–	1	1
„ 20	12	Harrington	Near Harrington	Bain, Blair, and Paterson	David Birnie	Hewer	35	Fall of stone	–	1	–	–	–	1
„ 16	13	Marley Hill	Near Gateshead	J. Bowes and Parts.	Ezekiel Vosper	Ditto	54	Fall of coal	–	1	–	–	–	1
„ 20	14	Asby	Near Arlecdon, Cumberland.	Asby Coal Company	Isaac Ashburn	Overman	44	Explosion of gas	1	–	–	–	–	1
„ 27	15	West Cramlington	Near Newcastle	Backworth and West Cramlington Coal Company.	John Wilkinson	Hewer	57	Fall of coal	–	1	–	–	–	1
„ 29	16	Diptón new winning.	Near Gateshead	R. Dickinson & Co.	H. Fairless	Sinker	28	Stone falling down shaft	–	–	1	–	–	1
May 12	17	Cambois	Near Blyth	Straker, Cookson, & Co.	James Barlow	Wailer	10	Run over by wagons	–	–	–	–	1	1
„ 15	18	Eden Pit, Consett.	Near Medomsley	Consett Iron Company	P. Straughton	Hewer	33	Fall of stone	–	1	–	–	–	1
„ 25	19	North Seaton	Near Blyth	Straker, Cookson, & Co.	John Ord	Ditto	38	Explosion of gas	1	–	–	–	–	1
„ 27	20	Clifton	Near Workington	I. and W. Fletcher & Co.	Thos. Pattinson	Ditto	22	Fall of stone	–	1	–	–	–	1
„ 29	21	Cowpen	Near Blyth	Straker, Cookson, & Co.	Daniel Quin	Driver	14	Crushed by tub	–	–	–	1	–	1
June 11	22	Harton	Nr. South Shields	Wood, Blackett, & Co.	John Wardle	Incline boy	12	Crushed by tubs from rope breaking	–	–	–	1	–	1
„ 12	23	Cramlington	Near Newcastle	Lamb, Potter, & Co.	Elisha Whitehouse	Hewer	22	Fall of stone	–	1	–	–	–	1
								Carried forward	2	8	6	5	2	23

List of Fatal Colliery Accidents—*continued*.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost in Coal Mines. Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868.								Brought forward	2	8	6	5	2	23
June 17	24	Harraton	Near Chester-le-Street.	Earl of Durham	Robert Ranson	Rolley-way man.	46	Fall of stone	–	1	–	–	–	1
					John Bessford	Stoneman	33	Ditto	–	1	–	–	–	1
„ 18	25	Broughton Moor	Near Maryport	John Harris	John Smith	Screener	72	Run over by wagons	–	–	–	–	1	1
„ 19	26	Bedlington	Near Blyth	Bedlington Coal Company	Geo. Jackson	Incline boy	16	Fall of stone	–	1	–	–	–	1
					Joseph Cook	Driver	14	Ditto	–	1	–	–	–	1
„ 20	27	New Delaval	Ditto	Straker, Cookson, & Co.	Robt. Smith	Banksman	25	Crushed by cage	–	–	1	–	–	1
„ „	28	Seghill	Near Newcastle	J. Laycock & Co.	Thos. Thompson	Onsetter's Assistant.	15	Iron bolt falling down shaft	–	–	1	–	–	1
July 1	29	Plashetts	Near Falstone	Laws, Tone, & Co.	Robert Cunningham	Driver	12	Run over by tub	–	–	–	1	–	1
„ 16	30	Mickley	Near Stocksfield	Mickley Coal Co.	Wm. McLachlan	Pony driver	14	Run over by set of tubs	–	–	–	1	–	1
„ „	31	Usworth	Near Gateshead	Geo. Elliot & Co.	D. Adamson	Hewer	26	Fall of stone	–	1	–	–	–	1
„ „	32	Cramlington	Near Newcastle	Lamb, Potter, & Co.	Wm. Robinson	Deputy	30	Ditto	–	1	–	–	–	1
Aug. 1	33	South Benwell	Ditto	Wm. Cochrane Carr	Geo. Williamson	Hewer	44	Ditto	–	1	–	–	–	1
„ 2	34	Ouston	Near Gateshead	Hunt, Perkins, & Co.	John Carr	Deputy	47	Explosion of gas	1	–	–	–	–	1
„ 3	35	Lintz	Ditto	Gooch & Co.	James O'Neill	Hewer	18	By stythe	–	–	–	1	–	1
„ 8	36	Cleator Moor	Near Whitehaven	Cleator Iron Co.	John McGuiness	Ditto	40	Fall of coal	–	1	–	–	–	1
„ „	37	Usworth	Near Gateshead	G. Elliot & Co.	John Goldboro'	Putter	18	Tub going amain on engine-plane	–	–	–	1	–	1
„ 14	38	Cowpen	Near Blyth	Straker, Cookson, & Co.	Wm. Johnson	Hewer	26	Fall of stone	–	1	–	–	–	1
„ 15	39	St. Helens	Near Maryport	Mulcaster & Co.	Jas. Robinson	Driver	14	Ditto	–	1	–	–	–	1
„ 17	40	North Seaton	Near Blyth	Straker, Cookson, & Co.	Jon. Maddison	Hewer	43	Ditto	–	1	–	–	–	1
„ 18	41	Eden Pitt, Consett	Near Medomsley	Consett Iron Co.	Thomas Tighe	Waiter-on	55	Fell down staple	–	–	1	–	–	1
„ 21	42	Beamish	Near Chester-le-Street.	Jas. Joicey & Co.	Robert Davison	Undergrnd. bank-rider.	18	Run over by tubs	–	–	–	1	–	1
„ 24	43	Harrington	Near Harrington	Bain, Blair, & Paterson	John Pye	Hewer	35	Fall of stone	–	1	–	–	–	1
„ 28	44	Dearham	Near Maryport	J. & T. Walker	Jas. Lancaster	Banksman	26	Crushed by cage	–	–	1	–	–	1
Sept. 15	45	Brayton Domain	Near Aspatria	Trustees of J. Harris	Thos. Barnes	Hewer	19	Fall of stone	–	1	–	–	–	1
„ 18	46	Backworth	Near Newcastle	Lamb, Taylor, & Co.	John T. Gibson	Fireman	22	Run over by wagons	–	–	–	–	1	1
„ 21	47	Cramlington	Ditto	Lamb, Potter, & Co.	Jas. Urwin	Furnaceman	55	Crushed by cage	–	–	1	–	–	1
„ 23	48	Crosby	Near Maryport	Mulcaster & Co.	Thomas Dixon	Shifter	49	Crushed by tub	–	–	–	1	–	1
„ 24	49	Usworth	Near Gateshead	G. Elliot & Co.	P. Docherty	Screener	60	Crushed by wagons	–	–	–	–	1	1
								Carried forward	3	21	11	11	5	51

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accident.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No of Lives lost in Coal Mines.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868.								Brought forward	3	21	11	11	5	51
Sept. 24	50	Washington	Near Gateshead	Bell, Kimpster & Co.	Jas. Sadler	Putter	16	Crushed by cage	–	–	1	–	–	1
Oct. 8	51	Gilcruix	Near Maryport	Gilcruix Coal Co.	Thos. Ritson	Hewer	45	Fall of stone	–	1	–	–	–	1
„ 10	52	Beamish	Near Gateshead	Jas. Joicey & Co.	Geo. Atkinson	Horsekeeper	48	Breaking of pit rope	–	–	1	–	–	1
„ 13	53	Mickley	Near Newcastle	Mickley Coal Co.	Robert Gair	Trapper	12	Run down by set of tubs	–	–	–	1	–	1
„ 17	54	Cramlington	Ditto	Lamb, Potter, & Co.	Wm. Hy. Masters	Hewer	20	Fall of stone	–	1	–	–	–	1
„ 29	55	West Stanley	Near Gateshead	D. Burn	Chas. Mitchell	Pony-putter	13	Crushed between tub and roof	–	–	–	1	–	1
„ „	56	Felling	Ditto	Geo. Elliot & Co.	John McTear	Hewer	39	Fall of stone	–	1	–	–	–	1
„ 30	57	Beamish	Ditto	Jas. Joicey & Co.	Thos. Tiplady	Wailer	12	Fell off tramway in coal shed	–	–	–	–	1	1
Nov. 3	58	Whitehaven	Near Whitehaven	Earl of Lonsdale	Peter Gibson, junr.	Driver	14	Crushed by a rolley	–	–	–	1	–	1
„ 4	59	Camerton	Near Maryport	Camerton Coal Co.	Jos. Irving	Hewer	22	Fall of stone	–	1	–	–	–	1
„ 19	60	Usworth	Near Gateshead	Geo. Elliot & Co.	Hugh McCann	Ditto	55	Ditto	–	1	–	–	–	1
„ 20	61	Monkwearmouth	Near Monkwearmouth.	Bell, Stobart, & Co.	Owen McGahan	Ditto	28	Ditto	–	1	–	–	–	1
„ 21	62	Choppington	Near Bedlington	Jobling & Co.	Arch. Hunter	Ditto	21	Ditto	–	1	–	–	–	1
„ 23	63	St. Helens	Near Maryport	Mulcaster & Co.	Michael O'Hare	Labourer	20	Fell from cage	–	–	1	–	–	1
Dec. 17	64	Walbottle	Near Blaydon	Lamb & Co.	Wm. Wheeler	Driver	14	Fell down staple	–	–	1	–	–	1
„ 22	65	Etal	Near Berwick	Johnson & Carr	Henry Mason	On-setter	18	Piece of coal falling down shaft	–	–	1	–	–	1
„ 24	66	Crosby	Near Maryport	Mulcaster & Co.	Jon. Donald	Hewer	45	Fall of top coal	–	1	–	–	–	1
„ 28	67	Radcliffe	Near Acklington	Jos. Harrison & Co.	Anthony Purvis	Ditto	36	Fall of coal and stone	–	1	–	–	–	1
								Total	3	30	16	14	6	69

Mr. Wardell's Report.

REPORT on the INSPECTION of MINES in the YORKSHIRE DISTRICT, for the Year ended 31st December 1868.—By FRANK N. WARDELL, Esq.

SIR, Pontefract, 27th February, 1869.

As Inspector of Mines for Yorkshire, I have the honour to transmit for your information my report for the year 1868.

I have much satisfaction in being able to report a diminution in the number of accidents by 7, as compared with the year 1867, resulting in a reduction of 11 in the number of deaths. There is at the same time an increase in the number of collieries, those opened out during the past year being in excess of those worked out, or from other reasons closed. Several are still in process of "winning."

That the total quantity of coal raised is less than that of the preceding year by nearly 150,000 tons, is, I believe, owing chiefly to the general depression of trade. The total produce of coal in the kingdom during 1868, is 104,600,000 tons, and the number of lives lost, 1,011, or one life lost per 103,461 tons.

In this district the total produce is 9,705,000 tons, and the number of lives lost, 80; or one life lost per 121,312 tons. This comparison is most favourable to Yorkshire.

SUMMARY of Separate Colliery Accidents in the Yorkshire District, during the Year ended 31st December 1868.

Explosions of fire-damp	5
Falls of roof	35
In shafts	11
Miscellaneous, underground	13
On the surface	13
Total	77

SUMMARY of Lives lost in the above Accidents.

Explosions of fire-damp	6
Fall of roof	36
In shafts	11
Miscellaneous, underground	13
On the surface	14
Total	80

SHAFT ACCIDENTS.

Whilst ascending and descending	2
Falling into shaft from surface	4
Falling from part way down	2
Things falling from part way down	2
Cage lowered upon him while repairing signal-wire at bottom of shaft	1
Total	11

MISCELLANEOUS—UNDERGROUND.

Explosion of gunpowder	2
On inclined planes	2
By trams and tubs	8
Filling dirt out of an old shaft, when a portion fell and buried him	1
Total	13

ON THE SURFACE.

By machinery	2
Boilers bursting	1
Chimney blown down	2
Struck by a post while repairing a gangway	1
Run over by waggons and carts	5
Fell off a waggon	1
Struck by arms of a capstan	1
While riding in a tub on an incline struck his head against a bridge	1
Total	14

LIST of COLLIERIES where FATAL ACCIDENTS have taken place during the year 1868.

Owner's Name.	Name of Colliery.	Deaths.
Earl Fitzwilliam	Park Gate	2
Aldwarke Main Co.	Aldwarke Main	1
T. M. Carter and Co.	Allerton Bywater	2
Farnley Iron Co.	Osmondthorpe Walsh	3
Newton, Chambers, and Co.	Thorncliffe	1
Cliffe Coal and Fire Clay Co.	Hollingthorpe	1
Lundhill Coal Co.	Lundhill	1
Jeffcock and Dunn	Carbrook	1
Messrs. Charlesworth	Warren Vale Rothwell Haigh Cosens Milnthorpe Thrybergh Hall Robin Hood	6
Isaac Wood and Son	Dean Lane	1
Sturges and Co.	New Gawber Hall	1
Rotherham, Masbro', and Holmes Co.	Holmes	3
Thrybergh Hall Co.	Thrybergh Hall	1
B. Huntsman	Soaphouse	1
Hird, Dawson, and Hardy	Upper George Mill Shaw	2
David Wroe and Co.	Heckmondwike Waterloo	2
Sharlston Coal Co.	Sharlston	1
Fence Coal Co.	Fence	1
Greenhough and Co.	Adwalton	1
Charles Winn	Nostell	1
J. and J. Haigh	Morley	1
Pope and Pearson	Silkstone	1
Monk Bretton Co.	Monk Bretton	1
B. Huntsman	Nunnery	2
Wombwell Main Co.	Wombwell Main	2
Edmunds Main Co.	Swaithe Main	1
W. Ingham and Sons	Wortley	1
Hudson and Co.	Victoria Silkstone	2
Silkstone Fall Co.	Silkstone	1
Joshua Bower and Sons	Preston West Allerton	3
Manston Coal Co.	West Yorkshire Manston	2
Kiveton Park Co.	Kiveton	1

List of Collieries where Fatal Accidents have taken place—*continued.*

Owner's Name.	Name of Colliery.	Deaths.
Rhodes and Harvey	Car House	2
Leather and Littlewood	Ellis Laith	1
Skinner and Holford	Waleswood	1
Bowling Iron Co.	Clifton Tong	2
H. Briggs, Son, and Co.	Methley Junction	1
A. Harding and Co.	Beeston Manor	1
J. Jackson	Great Gomersal	1
J. Leather	Waterloo Main	1
W. Ackroyd, Bros.	Morley Main	1
G. and J. Haigh	Ravensthorpe Alverthorpe	2
Wharncliffe Silkstone Co.	Wharncliffe Silkstone	1
West Yorkshire Co.	West Ardsley	1
E. Sutcliffe and Co.	Victoria	1
J. Baistow	Norwood Green	1
Blacker Main Co.	Blacker Main	2
Burnley's Executors	St. John's	1
Samuel Fox and Co.	Stocksbridge	1
Woolley Coal Co.	Woolley	1
Inspectors of Hoyland and Elsecar	Hoyland and Elsecar	1
Howley Park Co.	Howley Park	1
Locke and Co.	Kippax	1
Staveley Coal and Iron Co.	North Staveley	1
Garforth Coal Co.	Garforth	1
Asquith, Bros.	Howden Clough	1
William Day	Old Mill	1
	Total Deaths	80

MONTHLY STATEMENT of DEATHS caused by ACCIDENTS in the COAL MINES of the YORKSHIRE DISTRICT during 1868.

	Explosions.	Falls of coal and roof.	In shafts.	Miscellaneous.	Above ground.	Total.
January	—	8	3	2	1	14
February	1	3	4	1	3	12
March	—	2	—	1	1	4
April	—	5	1	2	1	9
May	—	3	2	1	1	7
June	1	3	—	—	1	5
July	—	2	—	1	—	3
August	—	2	—	1	1	4
September	—	—	—	—	1	1
October	—	4	—	3	2	9
November	1	1	1	1	1	5
December	3	3	—	—	1	7
Total	6	36	11	13	14	80

I have much pleasure in stating that this district was, in 1868, free from any of those very serious calamities, involving the deaths of many persons, which from time to time have occurred. Each fatal accident, with the exception of three, resulted in the death of one person only, and in each of the three exceptions the number killed was two.

There have been five fatal accidents from explosion of fire-damp, causing thereby the deaths of six persons.

Accident No. 17 in the Tabular List.

This is the first of the above-named, and occurred at Messrs. David Wroe and Sons' pit at Heckmondwike near Dewsbury, when two boys were burnt by an explosion of fire-damp whilst "hurrying" on the waggon-way about fifty yards from the bottom of the shaft. One of the boys, named Taylor, died from the injuries so received.

On an examination of the pit, I cannot say that I found the management good; and the pernicious system of mingling safety-lamps with naked lights was here (as it is at too many other collieries) in full force.

Gas occasionally showed itself in the workings, and, according to the evidence, at the inquest, of a collier named Redmayne, the men were in the habit of using lamps in the morning, sometimes changing them for candles towards the middle of the day, and this with the knowledge and under the direction of the steward.

On the morning of the explosion a terrific gale was blowing, and as the pit is only 36 yards deep, this may have had something to do with the disarrangement of the ventilation. The explosion took place, in all probability, at the furnace, flashing back through some old workings round to where the boys were "hurrying." These old workings were in close proximity to the furnace, and separated from it only by very inadequate "stoppings." One of the witnesses, Kitchenman, said that he had sometimes seen the gas "fire" at the top side of the furnace, before the accident occurred. Part of the workings of this pit were ventilated by the return air from another pit belonging to the same company, so that, instead of the men in this "Heckmondwike" pit having fresh air to breathe, they had vitiated air which had already done its duty in another pit. A verdict was returned by the jury of "accidental death," but they appended to it a censure on the proprietors for the deficient state of the ventilation in the mine. I requested Messrs. Wroe & Sons to have the old workings at the furnace effectually separated from it by proper and sufficient "stoppings" and to make a drift for the return air, at the same time advising the adoption of locked safety-lamps entirely throughout the pit, and the alteration of the ventilation so as to let the men in the "Heckmondwike" pit have fresh air.

Accident No. 47 in the Tabular List.

The deceased, Wm. Thompson, was a "hurrier," working for a man called Booth, alias Normanton. They were employed at the "Ravensthorpe" pit, near Dewsbury, belonging to Messrs. G. & J. Haigh. The place where the explosion of fire-damp occurred was an old "bank" which had been finished some two or three months. On the morning of the accident, Anderson, the bottom-steward, had visited every working place, and found all safe, with the exception of one place where there was a small quantity of gas. This place he temporarily stopped, and put up the usual signals, viz., crossed rails, and a board marked "Fire," according to the rules. It might be perhaps 200 yards from where the explosion took place. The "bank" which was finished, he had visited the day before, the special rules not requiring a daily inspection of the "places not working," but that they shall be examined "at least on every alternate day." He had then found it safe, and free from gas, with a proper current of air circulating through the air course. About eight or nine yards from this air-course, Normanton was working. After Anderson's examination of the old "bank," and previous to his inspection next morning of Normanton's working place, he (Normanton) had deliberately stowed away the "refuse" from his working place into the air-course, thereby building it completely up, and of course causing a stoppage there of the air. The reason for his so doing is only too obvious, to save himself trouble, as otherwise he would have had to remove the "refuse" a greater distance. One of the special rules distinctly states that, under penalty of fine or other punishment, no person shall "obstruct an air-course." On the morning of the explosion, requiring some rails, and thinking that there were some up this old "bank," he sent his "hurrier," Thompson, to procure them, the boy having a naked light. The consequence of this, owing to the stoppage of ventilation by the air-course being built up, and the accumulation of gas thereby, was that an explosion took place at his naked light, so seriously injuring him that he died shortly afterwards. Normanton had been told that morning by the steward where to obtain rails, should he require them, but as it was some eighty yards distant, to save time, he, in direct violation of rules, did as I have described. I considered that the bottom-steward, Anderson, was deserving of severe censure, in as much as he had examined Normanton's place on the morning of the explosion, and had actually passed within a yard of where the air-course was built up, without discovering it! It is the duty of a man holding the responsible position of underground manager to examine carefully all that comes under his notice while fulfilling his important duties. The coroner, very justly, severely remarked on this extreme carelessness. A verdict of manslaughter was returned against Normanton, who was committed to the Leeds assizes and properly punished.

Accident No. 70 in the Tabular List.

This accident also occurred in a pit belonging to Messrs. G. & J. Haigh, at Alverthorpe, near Wakefield. Upon examination, I found the system of ventilation not so good as it might have been, and other details connected with the general working of the mine capable of much improvement. On the north side of the pit each man had the fresh air; but on the south side, simply owing to deficient arrangements, some of the men had the return air. There was no reason why the south side could not have been similarly ventilated to the north; and on suggesting this and other improvements to the owners, they very properly agreed that the alterations should be made.

The deceased, David Ramsden, was a collier, and was working in a "bank" contiguous to a four-feet "throw," or dislocation of the strata. The place had been examined on the morning of the explosion by the deputy before Ramsden commenced working, who found it safe; and again, about two hours before the explosion, the underground steward was there, and observed no gas. Ramsden was helping the "hurrier" out with a "corf," and put his candle against one of the props, when the gas immediately fired, and both the man and boy were severely burnt, the man so much so, that he died soon afterwards. When the steward, David Lumb, visited the place before the explosion, there was a slight fall, but when he returned afterwards a heavy fall had taken place. Whether this fall took place, and thereby liberated a quantity of gas, or whether the fall was occasioned by the concussion of the explosion, is a matter of conjecture. In my opinion the steward was much to blame in allowing naked lights to be used here. There was no good reason he could bring forward to show the utility or necessity for so doing, and there were many reasons to the contrary. In the first place, the men working on either side had, by Lumb's orders, locked safety-lamps! the "bank" was ventilated by return air, and, in addition, was in close proximity to a throw where gas might reasonably be expected, more or less, to be given off. The place most certainly ought to have been worked with safety-lamps, in which case this explosion and loss of life would not, in all probability, have occurred. I have recommended the proprietors to use locked safety-lamps exclusively, and, at the inquest, the coroner spoke strongly in support of this opinion.

Accident No. 72 in the Tabular List.

Two men were killed by an explosion of fire-damp in the West Allerton Colliery, belonging to Messrs. Joshua Bower and Sons. This pit had, in the month of April, by some means taken fire, and after remaining sealed for four months, was opened out in August last. The greater portion of the workings had been duly explored before the explosion in December, and at the time of that misfortune a distance of only something like 200 yards was unexplored. It was here where the unfortunate men met their deaths. Charles Winn, a deputy, gave instructions to the two deceased, Crossland and Lee, to examine the air-courses. On the morning of the explosion he told them to go to the top south endings of the east bords. This was the unexplored portion; Lee was under Crossland's orders, the latter being considered an experienced practical man; Winn told them to use, and had provided them with Stephenson's lamps, giving them strict orders, as a matter of precaution, to use no other. They had, however, secretly disobeyed this order, obtaining Davy lamps from the cabin, which were found near their dead bodies. Nothing more was heard of them, and as they did not come out of the pit at their regular time, a search was instituted, and their bodies found in the south endings between two doors in the return air-way; the coal between these doors was sooty; their lamps were also found *locked and in good order.* The men who were working nearest to this place would probably be about 900 yards distant. One of them, Charles Gilsthorpe, stated that when working he felt what may have been the explosion; his candle was put out, but he also had an oil lamp which was not put out; there also seemed to be a slight check of the wind. He however concluded at the time that the cause of this was a fall somewhere in the pit. I am sorry to state that there was no regularly appointed lamp-keeper at this mine, and instead of *one* man having charge of, and being responsible for the lamps, *several* of the byeworkmen and deputies had keys. This laxity of discipline I laid before the owners, and was assured that the matter should be attended to.

Accident No. 74 in the Tabular List.

In the case of this accident, which took place at the Waterloo Colliery, near Dewsbury, belonging to Messrs. David Wroe and Co., I think it can only be attributed to that carelessness or utter recklessness so often unfortunately displayed. The deceased, Edward Sweeny, was a "hurrier," and was engaged at the time of the explosion in "hurrying" at this colliery. The deputy, Scargil, had that morning examined a place which was being "put through" a "throw." He found there a little gas, in consequence of which he got a pair of rails and put them across the place, according to rule, and chalked the word "fire" on them. He also told the boy Sweeny not to go there.

as there was gas. Notwithstanding all this, Sweeny deliberately went past the crossed rails with his naked light, and an explosion immediately followed, burning him so that he died a few days afterwards from his injuries.

I will now proceed to notice any details which strike me as deserving of remark, in the remaining accidents.

Accident No. 5 *in the Tabular List.*

This occurred at Thorncliffe Colliery, near Sheffield, belonging to Messrs. Newton, Chambers, and Co. Two men were clearing some earth and refuse from an old shaft-bottom; they were working with a long poker, six yards away from the bottom of the shaft, strict orders having been given them not to go into the shaft-bottom. Owing to the wet and slushy state of the debris, it came away quicker than they expected, and buried the deceased, George Coope, thereby suffocating him. The other man was knocked down, but otherwise uninjured. It did not appear that any carelessness or negligence on the part of any one was here exhibited.

Accident No. 8 *in the Tabular List.*

The deceased, Booth, was a boy who was employed at the Carbrook Colliery, near Sheffield, belonging to Messrs. Jeffcock and Dunn. He was engaged near the bottom of the shaft, when he was struck on the head by a wheel which fell from a corf ascending in the cage. The banksman stated that he observed the cage catch slightly at a "bunting" or cross beam about three or four yards from the top of the shaft, which appeared to drive the corf to one end of the cage. This may have been the cause of the wheel becoming detached from the axle, in fact it is the only way in which to account for the accident. The underviewer said that the shaft was in good order, and that no complaint had been made to him of any obstruction to the ascent or descent of the cage, which had been working all the morning up to the time of the accident, perfectly smoothly in the shaft.

Accident No. 10 *in the Tabular List.*

The unfortunate man, John Jowitt, was, it appeared, an inmate of the Clapham union, and was subject to fits which produced temporary insanity. Whilst in this state he had strayed from the union, and climbed over the railing at Dean Lane Pit, near Bradford, belonging to Messrs. Isaac Wood and Sons, and deliberately jumped down the shaft, of course meeting with instant death.

Accident No. 13 *in Tabular List.*

This case furnishes an instance of carelessness on the part of the deceased, and of the danger attending any violation of the special rules. Six men were about to ascend the shaft at Thrybergh Hall Colliery, belonging at that time to the Thrybergh Hall Co. (now the property of Messrs. Charlesworth), and got into the cage for that purpose. The signal was given to "go on," when the deceased attempted suddenly to get in, and was immediately caught between the cage and the roof. He was terribly mutilated, and died within a few minutes of the shocking occurrence.

Accident No. 16 *in the Tabular List.*

This accident occurred at the Walsh Pit, near Leeds, belonging the Farnley Iron Co., and resulted in the deaths of two men, J. Cowburn and J. Barraclough. These men were in a cabin near the mouth of the pit, when a chimney was blown down, which falling partly on the cabin, caused their deaths. The chimney was in an elevated and exposed situation, and it is right to mention that the gale raging at the time was one of extraordinary violence. From evidence obtained at the inquest, it appeared that the chimney had been built some eight years previously, and being found too low, was four or five years ago raised about five yards in height. The thickness at the base was three bricks, about half way up two bricks, and the remainder to the top one brick. A verdict of "accidental death" was returned; but it was very wisely and properly supplemented by an opinion that chimneys, in such exposed situations especially, should be built with sufficient thickness at the base to enable the summit to be finished with a thickness of two bricks.

Accident No. 18 *in the Tabular List.*

The deceased, C. Beaumont, in this case, whilst engaged in a shaft at Sharlston Colliery, belonging to the Sharlston Coal Company, assisting to lower the "bed of a stay," incautiously stepped off a plank on which he was standing, and was precipitated down the shaft. No blame appeared to be attached to any one, the accident arising from the poor man's own negligence.

Accident No. 22 *in the Tabular List.*

This accident occurred on the surface, at Messrs. J. and J. Haigh's Colliery, at Morley, near Leeds. The deceased, J. Myers, a carpenter, was engaged with another carpenter in repairing a "gangway" which had been partly blown down by the wind. They had removed some of the earth from the foot of an upright support, when it fell and struck the deceased on the head. The man, M^cDonald, who was working with him, stated that the post fell very slowly, and that deceased had ample time to have got out of the way, and further, that he, M^cDonald, shouted to him to do so. The unfortunate man, however, who was directly under the post, appears to have been as it were spell-bound, and quite incapable of moving. He did not seem to be much worse immediately after the accident, but in a short time alarming symptoms supervened, and he rapidly sunk from concussion of the brain.

Accident No. 24 *in the Tabular List.*

The deceased, P. Burns, was employed as a sinker in the "sinking pit" at Monk-Bretton, near Barnsley, belonging to the Monk-Bretton Coal Co. The shaft at the time of the accident was about fifty yards deep. The pumps in the shaft were a "hanging lift." It was customary to put in "chogs" or "stays" between the pumps and the shaft-side to keep the lift "plumb" or vertical, and for the purpose of preventing oscillation. Some "stays" were put in the night before the accident, about twelve feet from the top, at the delivery-pipe flanch. As the sinking proceeds the pumps are gradually lowered. They were lowered about seven inches at 3 o'clock on the morning of the accident. After that, the sinker in charge of the "shift" of men then working, carefully examined the shaft, paying particular attention to the "stays," which he found in proper order. About 4 o'clock a "shot" was fired, and it was shortly after this that the "stays" from some cause fell down the shaft, and struck deceased on the head, killing him on the spot. There is a hole through each "stay" or "chog" through which a rope is passed, and so they are lashed to the pumps. All due precaution appeared to have been taken, the master sinker, Bradley, and the man in charge of the "shift," both examined the shaft and pumps during the night. The concussion caused by the "shot" may in some way have loosened the "stays" by breaking the rope, and produced such melancholy and disastrous effects.

Accident No. 25 *in the Tabular List.*

This accident, like the last, occurred in a "sinking pit." The deceased, George Cotton, with other sinkers, was engaged at his work at the bottom of a shaft at the Nunnery Colliery, near Sheffield, when a piece of stone fell upon his head, causing such injuries as to produce his death within a very few hours. The shaft was then about 150 yards deep. The sides of the shaft had been regularly examined by the men in charge of the "shifts," and by the master-sinker. The shaft was also examined always between the firing of a "shot" and the men returning to the pit bottom. The following is the special rule which applies to this case, and I have every reason to believe it was strictly carried out:—"The master sinker must, during each shift, carefully examine the shaft, " and cause all loose pieces to be removed."

Accident No. 29 *in the Tabular List.*

In this case the deceased, John Parker, met with his death whilst engaged in firing a "shot" in the Dragon Pit at Wortley, near Leeds, belonging to Messrs. Ingham. Upon inquiring into the accident, I found that, without doubt, the unfortunate young man had been using his "pricker" in an improper and very injudicious manner, and, in fact, by doing what he and the rest of the miners had been repeatedly cautioned not to do. He had drilled the hole and was putting the powder in, and *striking his "pricker" with his hammer*, when it undoubtedly struck some hard substance and exploded the shot, killing him on the spot, and injuring his brother who was working with him. The "pricker" ought merely to be worked round with the *hand* and not *struck*. It presented the appearance after the accident, of a hook, the end having been completely bent by the striking. I recommended the owners to introduce a bye-law rendering the use of a hammer to a "pricker" a punishable offence. This I am glad to say they at once agreed to.

It is also a custom, too much in force, and one which cannot be too strongly condemned, to ram the "stemming" with an iron "rammer." By using a copper or wooden "rammer" and "pricker," I believe many accidents connected with blasting would be avoided.

Accident No. 35 *in the Tabular List.*

George Dickinson, the poor fellow who was killed in this case, seems to have been a man of nervous temperament, and occasionally subject to fits, indeed his death may perhaps be attributed to this nervousness. In my opinion, no man so constituted ought to be employed in or about shafts, where he is more peculiarly exposed to danger; and this unhappy instance fully bears me out in my conviction. Samuel Hambrough and the deceased were engaged in the shaft of the West Yorkshire Pit, Manston Colliery, belonging to the Manston Coal Co. They were upon a stage or scaffold some thirty yards from the bottom, wedging the tubbing. The tubbing was made tight in the October previous, it is 1½ inches thick, and the pressure is about 100 lbs. to the square inch. Whilst busy upon the stage, which was an ordinary semi-circular one, some of the tubbing was blown out. Dickinson, frightened and startled at this, stepped back, and fell off the scaffold down the pit, his death resulting in a few hours.

Nothing struck him, so that he was not in any way knocked back, but seemed to be so startled that he momentarily forgot where he was.

Accident No. 41 *in the Tabular List.*

This accident occurred at the bottom of the shaft at Waleswood Colliery, near Sheffield, the property of Messrs. Skinner and Holford. The deceased, Wm. Outram, was employed as a banksman at this colliery, and on the day of the accident he, in company with his brother, went into the shaft to repair the conducting rods. The two men previously to this had been examining the shaft from top to bottom, being let down slowly, first in one cage and then the other, for that purpose. Up to this time all went well, and it was during the repairing of the conducting rods, which was consequent on this examination, that the accident took place, the cage being lowered upon the men while they were standing in the bottom of the shaft. It appeared to me that this was done through a misapprehension of signals. The same engine-man was working the engine the whole time the examination and repairs were in progress, and he bore a very good character as a steady intelligent man who knew his business. Repeated signalling had been going on for some time whilst the rods were being repaired, the cage being moved up or down as the men required to be at a higher or lower elevation; and when it was lowered, and unfortunately killed Outram, it seems to have been rather from a misunderstanding than from any inattention or negligence. During the whole of the time there was a man stationed at the pit mouth, in accordance with the special rules.

Accident No. 43 *in the Tabular List.*

This, as well as the next four alluded to, was an accident on the surface; it however differs from the others in that it was a case in which the deceased, E. Rhodes, was killed through his own wilful and perverse recklessness. He, in company with some other young men, was proceeding along the road near to one of Messrs. Harding's disused shafts, at Beeston Manor near Leeds, on a Sunday evening, when his attention was caught by a bird's nest in the pulleys over the shaft. He immediately said he would "have it," and, though cautioned and repeatedly warned by his companions not to venture, persevered, and jumped upon the fencing round the shaft. He paid the penalty of his rashness, and fell to the bottom of the shaft, a depth of 27 yards, death being the immediate result.

Accident No. 44 *in the Tabular List.*

Hopkinson, the deceased, was employed in carting coals from Mr. Jackson's Colliery at Great Gomersal, near Leeds. When coming away from the pit, having filled his cart, one of the wheels caught against some timber which was lying on the ground, and in some way knocked him down and ran over him, his death transpiring almost immediately. According to the evidence of his father, who saw the accident, the boy would seem to have taken too sharp a turn with his cart, as the timber was quite out of the way of all traffic, there being a space of about twenty-seven feet between it and the pit-bank wall.

Accident No. 57 *in the Tabular List.*

This was an accident which took place at the Nunnery Colliery, near Sheffield, belonging to B. Huntsman, Esq. The deceased, R. Burns, was a labourer, and, together with some twelve or fourteen others, was engaged at the time of the accident in lowering some temporary "head-gear" over the pit top by means of a capstan. The power of fourteen men at the capstan was more than sufficient to lower this weight, but unfortunately as the "gearing" approached the ground, many of the men appear to have let go their hold, the consequence being that the weight overpowered the rest, causing the arms of the capstan to revolve very quickly and strike Burns on the head. There is no doubt that most of the men were thoughtlessly walking round, and not endeavouring to hold back the load and so let it down gradually. The consequence of their inattention to their work was the death of one of their fellow workmen.

Accident No. 62 *in the Tabular List.*

The accident arose during the unloading of a waggon of timber which was standing in a siding at the Howley Park Colliery, near Batley, the property of the Howley Park Coal Co. It occurred in so simple a manner as scarcely to deserve comment, and without dereliction of duty on the part of any one. The deceased, T. Allighan, was standing on the top of a waggon of timber, unloading it, when he by a false step overbalanced himself, falling over into the road and dislocating his shoulder. Expectations were at first entertained of his recovery, which however were not fated to be realized, as he died shortly afterwards.

Accident No. 67 *in the Tabular List.*

There is a tramway connecting the staiths with Kippax Colliery, on which this accident occurred. The colliery is the property of Messrs. Locke and Co., and is situated near Normanton. The deceased, Joseph Hewitt, was riding up to the pit in one of the tubs on this incline,—the men having permission so to do,—when he lost his stick into the tub next that in which he was seated, and during his attempt to regain it his head came in contact with a bridge, thereby dislocating his neck. The tramway at this bridge passes under the highway. There was no violation of any rule, and the accident can only be attributable to the poor man's forgetfulness of the danger, he having constantly travelled in the same way before. My opinion was that *if* men were allowed to travel in this manner, they should only do so at stated times, and then under the charge of one steady and careful man who would be responsible for their taking proper precautions to avoid similar accidents.

The number of accidents from falls of coal and stone is very large indeed. Out of the total number of 80 deaths in this district during 1868, there were 36 from this cause alone, or 45 per cent. Falls of coal and roof.

Too much attention cannot be paid to this subject, and it is one which I take every opportunity of impressing upon managers and stewards. The special rules in this district with regard to the use of timber are very stringent, and very justly so. It is therefore the duty of each in his station to do his utmost to see every rule carried out in its integrity. There is no rule more neglected, and none which in its violation produces so great a loss of life, as that which orders the miners to set short "props" or "sprags" at least every two yards, in "holing" or "baring" the coal. Much depends upon the miners themselves. In many cases an accident is the result of their wilful disobedience of this rule; and the utter disregard to safety which is too frequently displayed would indeed be incredible to all but those who are practically aware of the stern and veritable fact. Of course many of these falls occur when even all apparent care is taken, from "slips" in the roof, "partings," and other similar causes: the roof in such cases which has fallen and buried the unfortunate miner, will, an instant before, sound perfectly solid and safe.

It is the duty of all concerned in a mine to take every known and approved means for preventing accident; and so far as regards accidents from falls, where so much depends

Falls of coal and roof.

upon a regular and judicious use of timber, it is the duty, first, of the owners and agents to have at all times a sufficient supply of the same within reach; secondly, of the stewards and deputies to see, so far as they possibly can, every time they visit a man in his working-place, that he is carrying out the rules by a proper use of this timber; and thirdly, it is incumbent on the men themselves to take all due precaution for their own lives, and use every available means of safety which lies within their power.

There can be no greater mistake than to imagine that either a scant and insufficient supply of timber on the one hand is a pecuniary gain, or, on the other hand, that an obstinate refusal to use it when there is a saving of time. It is an established fact, though proved perhaps by a lamentable experience, that *true* economy consists in *safety.*

Fence-gates at top of shafts.

The use of properly constructed fence-gates at the top of shafts is becoming, I am happy to say, more general. I invariably advocate their adoption, as there is no doubt that they constitute a great safeguard, and are the means of preventing many accidents from persons falling down shafts.

Complaints.

The complaints I have received during the year have not been numerous. I have investigated them, and when they were based upon substantial grounds, succeeded in getting my suggestions and recommendations fairly carried out.

Non-fatal explosion at Emley Park.

In December an accident occurred in the Emley Park Colliery, near Wakefield, which, though serious, was providentially not fatal.

The cause of the accident was an explosion of fire-damp, which seriously burnt two men and two boys. They went to their working-places in the morning with naked lights. These places, it turned out, *had not been previously examined with a safety-lamp.* One of the special rules expressly states, that the "underground viewer or his "deputy shall, (with a *safety-lamp*) *daily* examine every travelling-road and working- "place, *before the miners and boys descend*... ... ... and if danger from "gas or from any other source be apprehended, he shall not allow a miner or boy to go "there until the danger is removed." The manager and his deputy did not bring forward any satisfactory reason for evading this rule, and did not even deny having done so. I found also, on examination, that the air-currents were not (in accordance with the special rules) measured regularly with an anemometer, that the furnace was not kept constantly in operation day and night, and that the fires were smothered with fuel; also that there was no indicator in the engine-house, nor was the fly-wheel securely fenced. Signals were improperly given by the hanger-on, and the engine-man was not at the pit in proper time to let down the viewer and his deputy.

For all these violations of the general and special rules, I, after receiving your instructions to prosecute, summoned the owner, manager, hanger-on and engine-man before the magistrates, and they pleading guilty were fined for each offence. I merely asked for nominal penalties, for the sake of example, there being every desire on the part of the owner to see that for the future every rule should be strictly enforced. I would advert here to the fact that managers like the one in this instance are too frequently to be met with, at small collieries where there is no very great output, and a comparatively small staff of officials. They are respectable men in their proper position, but quite out of place as managers of mines; and so long as such owners will not employ a better class of men as their managers, and offer sufficient inducement to obtain the services of experienced and skilled men, they must not be surprised if such accidents as these accrue. The magistrates, very properly, were most severe in their censure of the owner, and the general arrangements at the colliery. It is a matter of great thankfulness that the injuries to the unfortunate persons did not terminate fatally. The owner has promised, for the future, strict attention to the general and special rules.

I have, &c.
(Signed) Frank N. Wardell,
Inspector of Mines.

To the Right Hon. H. A. Bruce, M.P.,
Her Majesty's Principal Secretary of State,
Whitehall.

LIST of the FATAL COLLIERY ACCIDENTS, and LOSS OF LIFE arising therefrom in the YORKSHIRE DISTRICT, during the Year ending 31st December 1868.

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost in Coal Mines. Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868.														
Jan. 3	1	Park Gate	Rotherham	Earl Fitzwilliam	Thos. Brailsford	Collier	30	Fall of coal	–	1	–	–	–	1
" 4	2	Aldwarke Main	Ditto	Aldwarke Main Co.	John Bough	Ditto	35	Ditto	–	1	–	–	–	1
" 5	3	Allerton Bye-water.	Castleford	T. M. Carter & Co.	Sam. Coates	Ditto	35	Fall of roof	–	1	–	–	–	1
" 6	4	Osmondthorpe	Leeds	Farnley Iron Co.	A. Rouse	Ditto	35	Ditto	–	1	–	–	–	1
" 9	5	Thorncliffe	Sheffield	Newton, Chambers, & Co.	Geo. Coope	Ditto	—	Filling dirt out of an old pit, when a portion fell and buried him.	–	–	–	1	–	1
" 10	6	Hollingthorpe	Wakefield	Cliffe Coal & Fire Clay Co.	W. Atkinson	Trammer	15	Crushed by tubs at the bottom of an incline, through a chain breaking.	–	–	–	1	–	1
" 13	7	Lundhill	Barnsley	Lundhill Coal Co.	W. Smith	Collier	38	Fall of coal	–	1	–	–	–	1
" "	8	Carbrook	Sheffield	Jeffcock and Dunn	— Booth	Trammer	13	Axle and wheels from an ascending tub fell down the shaft upon him.	–	–	1	–	–	1
" 14	9	Warren Vale	Rotherham	Messrs. Charlesworth	A. Maughan	Ditto	28	Fall of coal	–	1	–	–	–	1
" 19	10	Dean Lane	Bradford	Isaac Wood and Son	John Jowitt	-	30	Threw himself down the shaft	–	–	1	–	–	1
" 22	11	New Gawler Hall.	Barnsley	Sturges and Co.	J. Capham	Collier	17	Fall of roof	–	1	–	–	–	1
" 25	12	Holmes	Rotherham	Rotherham, Masbro', and Holmes Co.	Elijah Briggs	Ditto	30	Ditto	–	1	–	–	–	1
" 27	13	Thrybergh Hall	Ditto	Thrybergh Hall Co.	F. McMann	Labourer	40	Caught by ascending cage, he having got in after the signal was given.	–	–	1	–	–	1
" 28	14	Soaphouse	Sheffield	-	H. Cheetham	-	—	Boiler tube collapsed	–	–	–	–	1	1
								Total for January	–	8	3	2	1	14
Feb. 1	15	Upper George	Bradford	Hird, Dawson, and Hardy	G. Woodhead	Collier	35	Fall of roof	–	1	–	–	–	1
" "	16	Walsh	Leeds	Farnley Iron Co.	J. Cowburn J. Barraclough	- -	19 38	Chimney, blown down in a gale, fell upon them whilst sitting in a cabin at the pit.	–	–	–	–	2	2
" 8	17	Heckmondwike	Dewsbury	David Wroe and Co.	J. Taylor	Hurrier	16	Explosion of gas	1	–	–	–	–	1
" 10	18	Sharlston	Wakefield	Sharlston Coal Co.	C. Beaumont	Labourer	47	Fell down the shaft	–	–	1	–	–	1
" 12	19	Fence	Rotherham	Fence Coal Co.	F. Pashley	Hanger-on	—	Run over by empty tubs	–	–	–	1	–	1
" 14	20	Adwalton	Leeds	Greenhough and Co.	Randall Ball	Collier	20	Fall of roof	–	1	–	–	–	1

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost in Coal Mines.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868. Feb. 17	21	Nostell	Wakefield	Charles Winn	H. Hargreaves	Deputy	40	Fall of roof	–	1	–	–	–	1
" "	22	Morley	Leeds	J. and J. Haigh	J. Myers	Carpenter	30	Whilst repairing a gangway, was hit by a falling post.	–	–	–	–	1	1
" 25	23	Silkstone	Ditto	Pope and Pearson	Ed. Minor	Mechanic	21	Scaffold gave way at bottom of shaft	–	–	1	–	–	1
" 27	24	Monk Bretton	Barnsley	Monk Bretton Co.	P. Burns	Sinker	60	Hit by a piece of wood which fell down the shaft.	–	–	1	–	–	1
" 27	25	Nunnery	Sheffield	B. Huntsman	W. Cotton	Ditto	31	Hit by a stone which fell from shaft-side	–	–	1	–	–	1
								Total for February	1	3	4	1	3	12
Mar. 9	26	Wombwell Main	Barnsley	Wombwell Main Co.	W. Hirons	Hurrier	37	Fall of roof	–	1	–	–	–	1
" "	27	Rothwell Haigh	Leeds	Messrs. Charlesworth	John Ward	Driver	17	Run over by a tip-wagon	–	–	–	–	1	1
" 24	28	Swaithe Main	Barnsley	Edmunds Main Co.	J. Bramwell	Byeworkman	25	Fall of coal when taking out puncheons	–	1	–	–	–	1
" 25	29	Wortley	Leeds	W. Ingham and Sons	John Parker	Collier	19	When stemming a shot, he struck his spindle against some ironstone, and the shot exploded.	–	–	–	1	–	1
								Total for March	–	2	–	1	1	4
Apr. 5	30	Wombwell Main	Barnsley	Wombwell Main Co.	Luke Maw	Nipper	13	Run over by tubs in a Jenny bank	–	–	–	1	–	1
" 8	31	Victoria	Wakefield	R. Hudson and Co.	J. Bastow	Collier	49	Fall of roof	–	1	–	–	–	1
" 11	32	Silkstone Fall	Barnsley	Silkstone Fall Co.	Geo. Walton	Hurrier	17	Ditto	–	1	–	–	–	1
" 16	33	Preston	Leeds	J. Bower and Sons	Geo. Atack	Driver	18	Run over by tubs	–	–	–	1	–	1
" 19	34	Allerton Byewater.	Castleford	S. M. Carter and Co.	Amos. Jackson	Collier	24	Fall of roof	–	1	–	–	–	1
" 20	35	West Yorkshire	Leeds	Manston Coal Co.	Geo. Dickinson	Sinker	47	Sheeting blown out of tubbing in which he was wedging, on a scaffold in the shaft, and so alarmed him that he stepped backwards off the scaffold and fell down the shaft.	–	–	1	–	–	1

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	No. of Lives lost in Coal Mines. Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868. April 26	36	Kiveton Park -	Sheffield -	Kiveton Park Co. -	John Lakin -	Labourer	54	When putting a rope on the engine drum the adjusting screw on the brake broke, and the brake straps fell upon him.	–	–	–	–	1	1
" 27	37	Car House -	Rotherham -	Rhodes and Harvey -	W. Dawes - W. Goodlad -	Collier - Ditto -	26 37	Fall of roof - - - - -	–	2	–	–	–	2
								Total for April - -	–	5	1	2	1	9
May 1	38	Ellis Laith -	Wakefield -	Leather and Littlewood -	Simon Jaggar -	—	—	Fall of roof - - - - -	–	1	–	–	–	1
" 2	39	Clifton -	Bradford -	Bowling Iron Co. -	John Brook -	Collier -	42	Ditto - - - - -	–	1	–	–	–	1
" 6	40	MethleyJunction	Normanton -	H. Briggs, Son, and Co. -	A. Kidd -	Hurrier -	16	Run over by a tub - - -	–	–	–	1	–	1
" 7	41	Waleswood -	Sheffield -	Skinner and Holford -	W. Outram -	Banksman	37	Repairing the signal wire at the shaft bottom, when the cage was lowered upon him.	–	–	1	–	–	1
" 8	42	Silkstone -	Wakefield -	Hudson and Co. - -	Thomas Colley -	Night-chargeman.	—	Fall of roof - - - - -	–	1	–	–	–	1
" 17	43	Beeston Manor	Leeds - -	A. Harding and Co. -	Ed. Rhodes -	Collier -	19	Fell down a disused shaft when bird-nesting.	–	–	1	–	–	1
" 18	44	Great Gomersal	Ditto - -	J. Jackson - -	J. Hopkinson -	Labourer	13	Run over by a cart when loading coals from the pit.	–	–	–	–	1	1
								Total for May - -	–	3	2	1	1	7

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868.														
June 4	45	Waterloo Main	Leeds	J. Leather	John Dobson	Collier	21	Fall of roof	–	1	–	–	–	1
,, ,,	46	Morley Main	Ditto	W. Ackroyd, Brothers	Jas. Holt	Hurrier	23	Ditto	–	1	–	–	–	1
,, 7	47	Ravensthorpe	Dewsbury	G. and J. Haigh	W. Thompson	Ditto	15	Explosion of gas in an old bank	1	–	–	–	–	1
,, 13	48	Wharncliffe Silkstone.	Barnsley	Wharncliffe Silkstone Co.	C. Hutchinson	Coal-washer.	60	Struck by a wheel	–	–	–	–	1	1
,, 25	49	West Ardsley	Leeds	West Yorkshire Iron and Coal Co.	W. Blakey	-	29	Fall of roof	–	1	–	–	–	1
								Total for June	1	3	–	–	1	5
July 10	50	Victoria	Barnsley	E. Sutcliffe and Co.	Geo. Mosby	Hurrier	12	Fall of coal	–	1	–	–	–	1
,, ,,	51	Norwood Green	Halifax	J. Baistow	John Ward	Deputy	58	Fall of roof	–	1	–	–	–	1
,, 13	52	Blacker Main	Barnsley	Blacker Main Co.	Fred. Seckor	Driver	15	Crushed between tubs and some props	–	–	–	1	–	1
								Total for July	–	2	–	1	–	3
Aug. 1	53	Holmes	Rotherham	Rotherham, Masbro', and Holmes Co.	Thos. Vernon	Driver	20	Crushed by wagons	–	–	–	–	1	1
,, 3	54	Park Gate	Ditto	Earl Fitzwilliam	E. Hoyle	Collier	57	Fall of coal	–	1	–	–	–	1
,, 6	55	St. John's	Wakefield	Burnley's Executors	H. Thackray	Ditto	25	Ditto	–	1	–	–	–	1
,, 22	56	Stocksbridge	Sheffield	S. Fox and Co.	W. Bailey	Hurrier	13	Wagon which brings the tubs from bottom of incline to surface broke, and part of it went back down the incline striking the boy	–	–	–	1	–	1
								Total for August	–	2	–	1	1	4

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868. Sept. 26	57	Nunnery -	Sheffield -	B. Huntsman - -	R. Burns -	Labourer	28	While working at the crab with others lowering pulley legs, the arms of the crab revolved rapidly, striking him.	–	–	–	–	1	1
								Total for September -	–	–	–	–	1	1
Oct. 2	58	Cosens -	Leeds - -	Messrs. Charlesworth -	F. Hutchinson -	Hurrier -	14	Crushed by a tub - - -	–	–	–	1	–	1
„ 7	59	Woolley -	Barnsley -	Woolley Coal Co. -	C. Leek -	Byework-man.	48	Run over by tubs - - -	–	–	–	1	–	1
„ 10	60	Hoyland and Elsecar.	Ditto - -	Inspectors of Hoyland and E. Colly.	G. Steeples -	Collier -	44	Fall of coal - - - - -	–	1	–	–	–	1
„ 17	61	Mill Shaw -	Leeds - -	Hird, Dawson, and Hardy	J. Robinson -	Ditto -	23	Fall of roof - - - - -	–	1	–	–	–	1
„ 20	62	Howley Park -	Batley - -	Howley Park Co. - -	J. Allighan -	Labourer	60	Fell off wagon of timber while unloading it.	–	–	–	–	1	1
„ „	63	Milnthorpe -	Wakefield -	Messrs. Charlesworth -	G. Thomas -	Hurrier -	12	Run over by wagon on which he was riding.	–	–	–	–	1	1
„ 21	64	Thrybergh Hall	Rotherham -	Ditto - - - -	J. Harvey -	Byework-man.	35	Crushed by a tub which ran amain down a jenny.	–	–	–	1	–	1
„ 24	65	Robin Hood -	Wakefield -	Ditto - - - -	W. Ramsden -	Hurrier	17	Fall of roof - - - - -	–	1	–	–	–	1
„ 29	66	Manston -	Leeds - -	Manston Coal Co. -	W. Hill -	Collier -	23	Ditto - - - - - - -	–	1	–	–	–	1
								Total for October - -	–	4	–	3	2	9
Nov. 5	67	Kippax -	Normanton -	Locke and Co. - -	Jos. Hewitt -	Staithman	66	While riding in a tub on an incline his head came against a bridge underneath which the tubs ran.	–	–	–	–	1	1
„ 6	68	North Staveley	Rotherham -	Staveley Coal and Iron Co.	Geo. Hill -	- -	—	Explosion of his shot - - -	–	–	–	1	–	1
„ 19	69	Tong - -	Leeds - -	Bowling Iron Co. -	John Hartley -	Hurrier -	14	Fell out of cage when descending the shaft. This is a gin-pit.	–	–	1	–	–	1
„ 23	70	Alverthorpe -	Wakefield -	G. and J. Haigh -	D. Ramsden -	Collier -	25	Explosion of gas - - -	1	–	–	–	–	1
„ 26	71	Garforth -	Leeds - -	Garforth Coal Co. -	T. Barber -	Byework-man.	50	Fall of roof - - - - -	–	1	–	–	–	1
								Total for November -	1	1	1	1	1	5

List of Fatal Colliery Accidents—*continued.*

Date.	No. of Accidents.	Name of Colliery.	Where situate.	Owner's or Agent's Name.	Persons killed.	Occupation.	Age.	Cause of Death, and Remarks.	Number of Lives lost.					
									Explosions.	Falls of Coal and Roof.	In Shafts.	Miscellaneous.	Above Ground.	Total.
1868.														
Dec. 10	72	West Allerton	Leeds	J. Bower and Sons	W. Crossland R. Lee	Collier Ditto	37 27	Explosion of fire-damp	2	–	–	–	–	2
„ 12	73	Holmes	Rotherham	Rotherham, Masbro', and Holmes Co.	J. Wolsterholme	Hurrier	17	Fall of roof	–	1	–	–	–	1
„ 17	74	Waterloo	Dewsbury	David Wroe and Co.	E. Sweeny	Ditto	12	Explosion of fire-damp	1	–	–	–	–	1
„ 19	75	Howden Clough	Leeds	Asquith, Bros., and Co.	J. Byewater	Coal sorter	11	Run over by a wagon	–	–	–	–	1	1
„ 20	76	Old Mill	Barnsley	Wm. Day	C. Hodgson	Collier	31	Fall of coal	–	1	–	–	–	1
„ 30	77	Blacker Main	Ditto	Blacker Main Co.	F. Padget	Ditto	34	Ditto	–	1	–	–	–	1
								Total for December	3	3	–	–	1	7
								Total for the Year	6	36	11	13	14	80

ELECTORAL RETURNS.

ELECTORAL RETURNS.

BOROUGHS AND COUNTIES,

1865—66.

Presented to both Houses of Parliament by Command of Her Majesty.

LONDON:
PRINTED BY GEORGE EDWARD EYRE AND WILLIAM SPOTTISWOODE,
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CONTENTS.

	Page
MEMORANDUM - - - - - - - - -	v

BOROUGHS.

Return A.—Population and Number of Electors - - - - -	1
„ B.—Working Classes on the Parliamentary Register - - - -	9
„ C.—Parliamentary and Municipal Electors - - - - -	23
„ D.—Boroughs in which the Small Tenements and Local Rating Acts are in force	31
With Abstracts 1, 2, and 3 - - - - -	37
„ E.—Male Occupiers - - - - - - - - -	43
„ F.—Gross Estimated Rental and Rateable Value and Income Tax Assessment -	55
Borough Summary - - - - - - - - - -	69
Number of Members returned for Boroughs - - - - - -	274

COUNTIES.

Return G.—Population, Male Occupiers and Electors. Gross Estimated Rental and Rateable Value - - - - - - - -	275
Number of Members returned for Counties - - - - - - -	287
A List of some of the principal Parliamentary Papers relating to Electoral Statistics since the passing of the Reform Act (2 W. 4. c. 45.) - - - - -	289

INDEX TO BOROUGH SUMMARY.

ENGLAND.

	Page
Abingdon	69
Andover	70
Arundel	71
Ashburton	72
Ashton-under-Lyne	73
Aylesbury	74
Banbury	75
Barnstaple	76
Bath	77
Bedford	78
Berwick-upon-Tweed	79
Beverley	80
Bewdley	81
Birkenhead	82
Birmingham	83
Blackburn	84
Bodmin	85
Bolton	86
Boston	87
Bradford	88
Bridgnorth	89
Bridgwater	90
Bridport	91
Brighton	92
Bristol	93
Buckingham	94
Bury (Lancashire)	95
Bury St. Edmunds	96
Calne	97
Cambridge	98
Canterbury	99
Carlisle	100
Chatham	101
Cheltenham	102
Chester	103
Chichester	104
Chippenham	105
Christchurch	106
Cirencester	107
Clitheroe	108
Cockermouth	109
Colchester	110
Coventry	111
Cricklade	112
Dartmouth	113
Derby	114
Devizes	115
Devonport	116
Dorchester	117
Dover	118
Droitwich	119
Dudley	120
Durham	121
Evesham	122
Exeter	123
Eye	124
Finsbury	125
Frome	127
Gateshead	128
Gloucester	129
Grantham	130
Greenwich	131
Grimsby, Great	132
Guildford	133
Halifax	134
Harwich	135
Hastings	136

	Page
Helston	137
Hereford	138
Hertford	139
Honiton	140
Horsham	141
Huddersfield	142
Huntingdon	143
Hythe	144
Ipswich	145
Ives, St.	146
Kendal	147
Kidderminster	148
King's Lynn	149
Kingston-on-Hull	150
Knaresborough	151
Lambeth	152
Lancaster	153
Launceston	154
Leeds	155
Leicester	156
Leominster	157
Lewes	158
Lichfield	159
Lincoln	160
Liskeard	161
Liverpool	162
London	163
Ludlow	164
Lyme Regis	165
Lymington	166
Macclesfield	167
Maidstone	168
Maldon	169
Malmesbury	170
Malton	171
Manchester	172
Marlborough	173
Marlow, Great	174
Marylebone	175
Midhurst	176
Monmouth	177
Morpeth	178
Newark	179
Newcastle-under-Lyme	180
Newcastle-on-Tyne	181
Newport (Isle of Wight)	182
Northallerton	183
Northampton	184
Norwich	185
Nottingham	186
Oldham	187
Oxford	188
Penryn and Falmouth	189
Peterborough	190
Petersfield	191
Plymouth	192
Pontefract	194
Poole	193
Portsmouth	195
Preston	196
Reading	197
Reigate	198
Retford, East	199
Richmond (York)	200
Ripon	201
Rochdale	202
Rochester	203
Rye	204

	Page
Salford	205
Salisbury	206
Sandwich	207
Scarborough	208
Shaftesbury	209
Sheffield	210
Shields, South	214
Shoreham, New	211
Shrewsbury	212
Southampton	213
Southwark	215
Stafford	217
Stamford	218
Stockport	220
Stoke-upon-Trent	219
Stroud	221
Sunderland	222
Tamworth	223
Taunton	224
Tavistock	225
Tewkesbury	226
Thetford	227
Thirsk	228
Tiverton	229
Totnes	230
Tower Hamlets	231
Truro	234
Tynemouth, &c.	235
Wakefield	236
Wallingford	237
Walsall	238
Wareham	239
Warrington	240
Warwick	241
Wells	242
Wenlock	243
Westbury	244
Westminster	245
Weymouth, &c.	247
Whitby	248
Whitehaven	249
Wigan	250
Wilton	251
Winchester	252
Windsor, New	253
Wolverhampton	254
Woodstock, New	255
Worcester	256
Wycombe, Chipping	257
Yarmouth, Great	258
York	259

WALES.

Beaumaris	260
Brecon	261
Cardiff	262
Cardigan	263
Carmarthen	264
Carnarvon	265
Denbigh	266
Flint	267
Haverfordwest	268
Merthyr Tydfil	269
Montgomery	270
Pembroke	271
Radnor, New	272
Swansea	273

ELECTORAL RETURNS.

MEMORANDUM.

The accompanying Returns have been obtained at the request of Her Majesty's Government, for the purpose of affording information with respect to the existing Borough and County Constituencies in England and Wales, and the probable addition which would be made to the present Number of Electors by an extension of the Franchise.

Boroughs.

With this view, instructions were given by the Poor Law Board (through which Department chiefly the Returns have been procured) that the following particulars should be ascertained and laid before the Government:

1. The Number of Borough Electors on the Parliamentary Register now in force, as compared with the Number in 1833, distinguishing such Electors according to their Qualifications, and deducting the double entries:
2. The Population of the several Parliamentary Boroughs at the same periods, or as near thereto as practicable:
3. The Number of Borough Electors who belong to the Working Classes:
4. The Number of Burgesses on the present Burgess Lists, showing how many of them are qualified in respect of premises for which the owner is rated, and how many of them are on the Parliamentary Register:
5. The Boroughs in which the Small Tenements Rating Acts, or any Local Acts authorizing the rating of Owners instead of Occupiers, are in force:
6. The Number of Male Occupiers in Boroughs at certain specified Rateable Values down to 4*l.*:
7. The total Gross Estimated Rental of each Borough, according to the Valuation Lists or last Poor Rate; the Gross Estimated Value according to the Income Tax Assessment; and the Gross Estimated Rental and Rateable Value, as shown in the Poor Rates prior to the passing of the Union Assessment Committee Act, 1862.
8. And with respect to Counties, the Number of Male Occupiers at certain Rateable Values, ranging from 10*l.* to 50*l.*, and also at and above 50*l.* Gross Estimated Rental; the Number of Electors on the Register as Occupying Tenants; the total Number of Electors on the Parliamentary Register, as compared with the Number on the Register of 1833; and the Gross Estimated Rental and Rateable Value of the Property in each County or Electoral Division before and since the passing of the Union Assessment Committee Act, 1862. Counties.

The information, which has been obtained in relation to the foregoing subjects, is contained in the Returns A., B., C., D., F., and G., and the annexed Abstracts.

Return A.

Boroughs. Population and Electors.

This Return shows, in respect of the several Boroughs, the increase or decrease between the Population in 1831 and the Estimated Population in 1866; the increase or decrease between the total Number of Electors on the Parliamentary Register for 1832–3, and the Register for 1865–6; the present actual Number of Electors, after deducting double entries, and the Number of Electors who voted at the last General Election.

The Estimate of the Population for 1866 has been made by the Registrar General, and the principle upon which his computation is based is the same as that adopted for the Parliamentary Return in 1859 (No. 121.), and will be found explained in a note at the foot of the present Return.

The Number of Electors on the Register for 1832–3 has been taken from the Return No. 189. (1833).

The descriptions of the qualifications which were reserved by the 2 W. 4. c. 45. (the Reform Act) have been corrected, where necessary, and in those few instances where the Number of Voters was not inserted in the Return for 1833, the defect has been supplied from the Return No. 329. (1838).

The Number of Electors on the present Register has been obtained through the Home Office from the Returning Officers, who have also supplied the information necessary for filling up the column which shows the Number of Electors who voted at the last General Election.

Return B.

Analysis of Registers.

This Return gives the Number of Borough Electors on the Register for 1865–6, distinguished according to their several qualifications, and the Number of Electors who belong to the Working Classes.

The Returning Officers have been enabled to state the Number of Electors whose names are entered more than once upon the Register in respect of double qualifications. In a few cases, where the Returning Officers have been unable to supply this information, the number of duplicate entries has been obtained either from the Registration Agents or the Union Clerks. In order to render the statistics relative to the Number and Qualifications of Electors as accurate as possible, the figures furnished by the Returning Officers have been compared in most instances with the Registers themselves.

Number of Working Classes in possession of the Franchise.

With regard to that portion of Return B. which shows the Number of the Working Classes, the particulars have been obtained, through the agency of the various Union Clerks, from those Union and Parochial Officers whose duties necessarily bring them into frequent communication with the ratepayers of each locality.

The instructions given for the guidance of the officers engaged in this investigation were, that, having so much of the Register as related to their respective parishes handed to them, they should place a tick opposite the name of every Elector coming within the description of *Mechanic*, *Artizan*, *or other Person supporting himself by daily manual labour*. A further direction was given that no Elector was to be excluded because he has a shop which is kept by his wife or other member of his family.

In the event of the Clerk finding that the Rate Collectors or Assistant Overseers were not the best qualified for the performance of the prescribed duty, he was requested to avail himself of the assistance of any other persons who might appear better able to render the services required.

Shortly after these Instructions were issued the Board became apprehensive, from inquiries which had been addressed to them, as well as from an inspection of some of the Returns which had been received, that there might be some misunderstanding as to the persons to be included in the Return; and in order to satisfy themselves that the Returns had been prepared without any misapprehension of their Instructions, they issued the following Circular:

" Poor Law Board, Whitehall, S.W.,
" Sir, 2d January 1866.

" I am directed by the Poor Law Board to acknowledge the receipt of the Return " Occupations of Voters," which you have been so obliging as to procure for them.

" The Board find, from communications which have been addressed to them, that in some instances there appears to be some misapprehension with respect to the persons intended to be included under the description of " mechanics, " artizans, and other persons supporting themselves by daily manual labour," and the Board are desirous of satisfying themselves that the Return received from you has been prepared without any misunderstanding of their intentions.

" The Board direct me to point out that the object of the Return is to show the Number of Electors on the Parliamentary Register now in force who would ordinarily be understood to come within the designation of " the " Working Classes."

" The Board do not intend that the Return should be exclusively confined to journeymen who are employed by masters at daily or weekly wages, but that it should include men who work daily at their own handicraft trade without a master, and even sometimes employ a journeyman or an apprentice, provided they derive their chief support from their own hand labour, and not from the labour of others, or the profits arising from the employment of capital, or the supply of materials.

" The Board have already stated in a note to the Form of Return that no artizan, mechanic, or labourer is to be excluded because he has a shop which is kept by his wife or other member of his family; but it must be distinctly understood, that, as a general rule, shopkeepers and their shop assistants are not to be inserted.

" The Board think it right to add that overlookers, superintendents, foremen, and others employed among or in connexion with operatives, workmen, or other daily labourers are not be included, unless actually employed in daily manual labour in the same manner in every respect as the men who are under them.

" The Board request that, having regard to the preceding explanation, you will have the goodness to inform them, if any, and if so, what alteration is required in the Return furnished by you.

" I am, Sir, your obedient Servant,
" Enfield, Secretary."

With very few exceptions, the Clerks in their replies to this Circular stated that they had not misunderstood the Board's intentions, and that the numbers returned by them were correct. In the exceptional cases referred to the Returns were sent back, and subsequently amended.

When the Returns had all been received it was found that the proportion of the Working Classes to the other Electors varied very considerably in different Boroughs; and wherever the proportion appeared to be in excess of the average number of that class on the Parliamentary Register for other Boroughs, and no satisfactory explanation of the circumstance could be collected from the Returns, the Clerk was requested to state whether there were any peculiar circumstances connected with the Borough, in consequence of the existence of manufactories or the general condition of the Working Classes themselves, which would account for a larger number than ordinary possessing the Franchise. The Clerk was at the same time informed that it had been ascertained that "in some instances such persons as small shopkeepers who " served in their shops, not being artizans or mechanics; butchers, who are " salesmen or keep a butcher's shop; farmers, who work themselves on the " land which they rent; dairymen, who live by the profits from their cows; " persons who keep a horse and cart, and let them out, &c., have been included " in the Return;" and the Register was forwarded to him with a request that the occupation of the Voter should be inserted in every case where his name had been ticked off as belonging to the Working Class.

The Registers containing the additional information required have since been examined, and the Returns, where necessary, revised.

Letters of inquiry have also been addressed to the Union Clerks in those cases where the number of Working Men has appeared to be unusually small.

The Borough Summary, which accompanies the Return, contains the substance of the explanations which have been received in relation to the points just referred to.

Return C.

Municipal Electors or Burgesses.

The object of this Return is to furnish a basis for the comparison of the Parliamentary with the Municipal constituencies in Boroughs. It shows the Number of Electors on the Parliamentary Register, the Number of Burgesses on the Burgess List, the Number of such Burgesses whose Rates are assessed on the Owner or compounded for by him, and the Number who are on the Parliamentary Register; at the same time indicating whether the Parliamentary and Municipal boundaries are conterminous or not.

The Burgess Returns have been furnished by the Town Clerks of the several Boroughs. The numbers are taken from the Burgess Lists for the present year, but the double entries have not been deducted, in consequence of the difficulty of identifying the Electors in those Boroughs where the number is very great. In order that the comparison between the two constituencies might be made upon the same data, the Number of Parliamentary Electors, as shown in this Return, is also inclusive of double entries.

Return D.

In explanation of this Return it should be stated that there are two General Acts authorizing the rating of the owners of small tenements instead of the occupiers—

Small Tenements and Local Rating Acts.

1. The 59 Geo. 3. c. 12., with a rating limit not exceeding 20*l.* nor less than 6*l.* annual rental:

59 G. 3. c. 12.

2. The 13 & 14 Vict. c. 99., usually known as "The Small Tenements Act," with a rating limit not exceeding 6*l.* annual rateable value.

13 & 14 Vict. c. 99.

These Acts are not compulsory, and it rests with the vestry of each parish to determine whether the Acts shall be adopted or not.

There is a distinction, however, between the powers of the vestry with respect to the rating limit. Under the first Act—the 59 Geo. 3. c. 12.—the vestry may fix the limit at any amount not less than 6*l.* nor more than 20*l.* Under the 13 & 14 Vict. c. 99. they have no such discretion; but if they resolve that the Act shall be adopted, all Tenements, the yearly Rateable Value of which shall not exceed 6*l.*, are necessarily brought within its provisions.

The 59 Geo. 3. expressly enacts that the owner shall not be rated in places where the right of voting for Members of Parliament depends on rating; but there is some doubt whether this enactment applies to boroughs created since the passing of the Reform Act of 1832.

Besides these two General Acts there are several Local Acts authorizing the rating of owners instead of occupiers.

The occupiers of tenements for which the owners are rated are usually described as "Compound Householders."

Compound Householders.

The present Return (D.) shows—

1. The number of Boroughs in which the Small Tenements Act, 13 & 14 Vict. c. 99., is in force throughout the whole Borough:
2. The Boroughs in which the Act is in force but not throughout the entire area of the Borough:
3. The Boroughs in which the Act has not been adopted, distinguishing those in which any Local Rating Act is in force:
4. The Boroughs in which the Small Tenements Act and also a Local Act or Acts for rating are in force:
5. The Boroughs in which the provisions of the 59 Geo. 3. c. 12. s. 19. have been adopted throughout the whole or part of the area:
6. The Boroughs in which Local Acts for the rating of owners instead of occupiers are in force, with a column showing the limits of rental or value to which such Act applies.

This Return has been partly compiled from the Parliamentary Paper No. 33. (1862) and partly from information subsequently obtained by the Poor

Law Board, and a careful examination of the several Local Rating Acts in force in the different Boroughs.

Qualification for a Burgess.

In order to understand the effect of the several General and Local Rating Acts upon the Municipal Franchise, it must be remembered that the following qualifications are required for a Burgess :—

1. That he should have occupied for two years and eight months a house, warehouse, counting-house, or shop within the Borough :
2. That he should have been an Inhabitant Householder within the Borough, or within seven miles, during the period of his occupation.
3. That he should have been rated for the Relief of the Poor in respect of the premises so occupied, and paid all rates except those becoming due within the preceding six months.

5 & 6 W. 4. c. 76.

At the time of the passing of the Municipal Corporation Act in 1835, the 59th Geo. 3. c. 12. had been adopted in some Boroughs, and in several others Local Rating Acts were in force. In order, therefore, that the occupiers of property for which the owner was rated might not be excluded from the Franchise the Municipal Corporation Act provided that the occupier may claim to be rated, and that upon paying or tendering the full amount of the last rate payable in respect of the premises occupied by him he shall be deemed to have been rated from the date of that rate.

In 1850 the 13 & 14 Vict. c. 99. (the Small Tenements Act) was passed, and during its progress through Parliament a clause was inserted in it to the effect that where the owner was rated instead of the occupier under its provisions, and the owner should have paid the rates, the occupier should be entitled to the Municipal Franchise in the same manner as if he himself had been rated and paid the rates.*

By the 21 & 22 Vict. c. 43. a similar provision was made in regard to the Municipal Franchise in those Boroughs in which the 59 Geo. 3. c. 12. was in force.

The following distinction must, therefore, be borne in mind with respect to the Municipal Franchise so far as regards the condition of rating in those Boroughs where statutory provisions are in force for rating owners instead of occupiers.

In the Boroughs where either or both of the General Acts for rating Small Tenements have been adopted Compound Householders are exempted from the necessity of being rated or claiming to be rated. Their names need not appear in the Rate Book at all, and if the owner has paid, or they, in default of payment by him, have paid all the rates except those due within the preceding six months, they will be entitled to be placed upon the Burgess Lists. The law, however, is different where the owner is rated under a Local Act, except in one or two Boroughs where the Local Act contains a saving clause similar to those already referred to ; with these exceptions the Compound

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* The 14 & 15 Vict. c. 39., passed in the following year, provided in like manner for the protection of the ancient Parliamentary Franchises reserved or retained for Freemen and others by the Reform Act.

Householder whose name has been omitted from the rate must still claim to be rated, and if necessary renew his claim with each succeeding rate during the whole of the prescribed period of occupation.

The Abstracts appended to Return D. are limited to the Municipal Statistics of those Boroughs which have the Parliamentary and Municipal Boundaries conterminous.

Abstract 1. shows the Boroughs in which the Small Tenements Act has been either wholly or partially adopted, and it supplies, from the Report of the Select Committee of the House of Lords on the operation of that Act (see Parliamentary Paper No. 46, 1859), the number of Burgesses on the Lists before the Act was adopted as contrasted with the number having the Franchise at the present time.

Abstract 2. relates to those Boroughs in which Local Rating Acts are in force.

Abstract 3. relates to those Boroughs in which there is no Statutory provision for rating the owners instead of the occupiers.

These abstracts are intended to show the effect of the Small Tenements Act and the Local Rating Acts in diminishing or increasing the Municipal Constituencies.

Return E.

Male Occupiers.

This Return furnishes the Number of Male Occupiers in Boroughs who are assessed upon a Gross Estimated Rental, and Rateable Value at various fixed Amounts, commencing at 4*l.* and extending upwards; the Number of Inhabited Houses in 1861; and the Number of Electors on the Parliamentary Registers now in force as £10 Occupiers.

In 1860, Returns almost similar to these were presented to both Houses of Parliament, and they afterwards formed the subject of investigation by the Select Committee appointed by the House of Lords, to inquire what would be the probable increase of the Number of Electors in the Counties and Boroughs of England and Wales from a reduction of the Franchise.

The Returns of 1860 were taken from the Rate Books, and it was established by the Evidence taken before the Committee, that under the then existing system of Rating the data furnished from that source could not be relied upon as satisfactory evidence of value.

The Union Assessment Committee Act, 1862.

Since that time Mr. Villiers' Union Assessment Committee Act has been passed. Under its provisions the Poor Law Guardians are required to appoint an Assessment Committee, one third being ex officio Guardians, to regulate and settle a uniform valuation of all the assessable Property in the several Parishes of their respective Unions.

Valuation Lists.

The documents in which these Valuations appear are termed Valuation Lists, and the Act requires that they shall set forth the names of the Occupiers and Owners of the Property assessable, and the Estimated Extent, the Gross Estimated Rental, and the Rateable Value of each separate Occupation.

Gross Estimated Rental.

The Gross Estimated Rental is defined to be the Rent at which the Property might be reasonably expected to let from year to year, the tenant taking upon himself all tenant's rates and taxes, and the Tithe Commutation Rentcharge, if any.

Rateable Value.

The Rateable Value is the Amount of such rent, deducting therefrom the probable average annual cost of the repairs, insurance, and other expenses, if any, necessary to maintain the premises in a state to command such rent.

Objections to Valuation Lists.

The Valuation Lists are in the first instance made out by the Overseers, and delivered in duplicate to the Assessment Committee. Any Ratepayer in either of the Parishes of the Union, may, if aggrieved by his Assessment, object to it, and the Assessment Committee are empowered, with the consent of the Guardians, to direct a Revaluation of all or any of the Parishes within their Union. After the Valuation Lists have been finally approved of by the Assessment Committee, one copy is delivered to the Guardians, and another remains in the custody of the Clerk to the Guardians.

Appeal against Rate.

The Valuation Lists are not conclusive, and any person who is dissatisfied with the decision of the Assessment Committee may afterwards appeal against the Rate to the Special or Quarter Sessions, and the Judgment of the latter may be reviewed in the Queen's Bench in the ordinary way.

No Rate for the Relief of the Poor can be enforced unless the property included in it is rated according to the annual Rateable Value appearing in the Valuation Lists. Moreover, the Overseers are required to sign a declaration at the foot of the Rate that the several Hereditaments are rated according to the Value appearing in the Valuation List; and any Overseer who wilfully makes such Declaration falsely incurs a Penalty not exceeding £5.

There are in England and Wales 652 Unions, including about 71 places under Local Acts and Gilbert's Act (22 Geo. 3. c. 83.), and also a few Parishes under separate Boards of Guardians. To these separate Parishes the Union Assessment Committee Act does not apply, but the Unions and Incorporations under Local Acts or Gilbert's Act are empowered to adopt its provisions, with the consent of the Poor Law Board, and four of them have already done so.

The Number of Parishes and Townships in England and Wales is about 15,000. Prior to the passing of the Union Assessment Committee Act very great variations were found in the mode of Assessment. In many instances the difference between the Gross Estimated Rental appearing on the Rate Book and the actual Rental was from 20 to 30 per cent., whilst in other cases it amounted to no less than 50 per cent. The discrepancies between the Rateable Value and the Gross Estimated Rental were equally great.

The Act to regulate Parochial Assessments (6 & 7 Will. 4. c. 96.) provided that no rate should be allowed by the Justices which should not be made upon an estimate of the net annual Value of the several hereditaments rated thereunto, that is to say, the rent at which the same might reasonably be expected to let from year to year, free of all usual tenant's rates and taxes, and Tithe Commutation Rentcharge, if any, and deducting therefrom the probable average annual cost of repairs, insurance, and other expenses, if any, necessary to maintain them in a state to command such rent. In practice, however, this enactment was often disregarded by the Overseers, who had an object in reducing the assessable value of the property within their Parish, in order that they might lessen the contribution to the County Rate, and so long as the Overseers and Parishioners were satisfied with the rating there was no remedy for the irregularity. If the Overseers were willing to sign the Statutory Declaration that the Rate was correct, the Magistrates had no alternative but to allow it, their duty being merely ministerial; and if the Parishioners were rated fairly, *inter se*, they had no motive whatever for appeal. **The Parochial Assessment Act.**

Since the passing of the Union Assessment Committee Act in 1862, Assessment Committees have been appointed in 581 Unions, and in 503 of them the Valuation Lists have been completed.

Under the new system, all the Parishes in the same Union must necessarily be assessed upon the same principle; and although the Returns show that the scale of deduction from the Gross Estimated Rental is not always uniform as between different Unions, it will be observed that the Union Clerks, with very few exceptions, state that the Gross Estimated Rental represents the full rack rent.

The total number of Parliamentary Boroughs in England and Wales is 200, and the Act is in force in all of them with the exception of 31. The names of these Boroughs are printed in the Return in larger type in order that they may be distinguished from the rest.

The Return E., as will be seen by reference to it, shows the number of Male Occupiers assessed in the Gross Estimated Rental Columns and the Rateable Value Columns of the Valuation Lists at certain stated amounts, commencing with 4*l.* and extending upwards. In those cases where there are no Valuation Lists the particulars required have been extracted from the Poor Rate.

The number of Occupations at a Gross Estimated Rental has been taken chiefly from the Return moved for by Mr. Baines at the close of the last Session, and recently presented to the House of Commons, but no deduction has been made in the present Return on account of Female Occupiers and unoccupied property in those places where the number of Tenements and not the number of Male Occupiers only is given. Parliamentary Return, No. 81, 1866.

The Statistics with regard to both the Rental and Rating Occupations have been supplied by the Union Clerks, except in those few instances of Parishes not under a Board of Guardians, when the Forms have been filled up by the Vestry Clerks or the Overseers.

A considerable portion of the information contained in Mr. Baines's Return was obtained early in the autumn, but the circulars applying for the number of Rating Occupations were not issued until the 30th of November. It is proper to mention this circumstance, as it has been ascertained that, in a few Unions, to which the Union Assessment Committee Act is applicable, the number of Rental Occupations was taken from the Poor Rate in consequence of the Valuation Lists not being at that time complete, whilst in others the Supplemental Valuation Lists from which the Rating Occupations are enumerated had been approved since the number of Rental Occupations was given in.

Instructions for Return.

The following are the instructions which were issued for making out the Return of Rating Occupations:

" Instructions for making out the Return.

" The object of this Return is to ascertain, with the greatest possible accuracy, the Number of Male Persons *resident within the Parliamentary Borough, or within seven miles thereof*, who are assessed in the last Poor Rate, as Occupiers of *a House or other Building, with or without Land*, within the Borough, the Rateable Value of which is *at and above* 4*l.*, classified according to the accompanying Form :—

" 1. The Number of Males only is required. All *Women* entered as Occupiers are therefore to be excluded.

" 2. The Number of Persons only is required. Where, therefore, one Person is assessed within the Borough for several of such tenements he will be only entered once, and that in respect of the tenement of the highest value.

" 3. It is only the Number of Persons *resident within the Parliamentary Borough, or within seven miles thereof*, that is required. Any Person, therefore, who may be assessed in the Rate in respect of a tenement occupied by him within the Borough, but who does not reside within the above-mentioned limit, must be excluded from this Return.

" 4. It is only the Number of Occupiers that is required. All tenements, therefore, must be wholly omitted from the Return which are entered as *unoccupied*.

" Also where, under the operation of the Small Tenements Act or any local Act, the *Owner* is assessed instead of the *Occupier*, it is the Occupier who alone must be entered in this Return, according to the rateable value of the tenement which he occupies. If the names of the Occupiers of these tenements do not appear upon the Rate, so that the number of female Occupiers cannot be ascertained, the number of tenements must be entered as the number of Occupiers, and a note stating when this is the case should be added to the Return.

" 5. When several persons are *jointly assessed* in respect of a single tenement they should be entered as *separate Occupiers* of tenements, calculated at a proportionate part of the whole value of the single tenement. Thus, if A., B., and C. are assessed jointly for a tenement, the rateable value of which is 21*l.*, each of these ought to be entered as an Occupier of a tenement at a rateable value of 7*l.* If either of them is a female, or resides more than seven miles from the Parliamentary Borough, such Occupier must be excluded.

" 6. Especial care must be taken, in cases where *part* of a Parish is *within* and *part without* the Parliamentary Borough, that only such Persons as are assessed in respect of *tenements within the Parliamentary Borough* shall be included in this Return.

" *Poor Law Board, Whitehall,*
" 30 *November* 1865."

Instructions almost similar to the preceding were given for the preparation of the Return of Rental Occupations.

Houses let in distinct Tenements.

In the Metropolis, and in a few other large towns also, there are certain houses which are let out in separate Tenements or Floors, the landlord himself not residing on the premises, but being rated for the whole house. In these cases the tenants' names seldom appear on the Rate, or if they are entered on the Rate there is nothing to indicate the number or value of the separate Occupations. There was reason to presume that such houses as these would appear in the Valuation List, or Rate, as above the Rateable Value of 10*l*. each, and be entered accordingly in the Returns. A Circular was therefore addressed by the Poor Law Board to the Union Clerks and Parochial Officers of every Borough, with a Population exceeding 50,000 Persons, requesting them to state whether in the Return furnished by them there were any, and if so, how many Houses of the description referred to. They were also requested to state whether it would be practicable, without a house-to-house visitation, to ascertain or estimate the Number of such separate Occupations, and the Annual Value of each; and they were reminded that the Board did not refer to those cases where the owner himself resides on part of the premises, or where a tenant takes the whole house, residing in part himself and sub-letting the remainder to lodgers.

The replies to this Circular show that houses let out in distinct Tenements in the manner described are chiefly to be found in the Metropolis.

The information which has been obtained with respect to these houses, where they are found to exist, is given in the Borough Summary referred to hereafter.

It will be observed on comparing the number of Rental Occupations at 10*l*. and over with the Number of Electors on the Register that in some Boroughs the number of the latter is in excess of the former. Whenever this has appeared to be the fact the cause of the variation has been inquired into, and the substance of the explanation in each case is likewise given in the Borough Summary.

In computing the probable addition to the constituency of any Borough by an extension of the Franchise to any given amount of Rental, or Rateable Value, reference should be made to the Borough Summary to ascertain whether the assessment in the Valuation Lists or Poor Rates is made upon a proper basis, and whether the deductions in order to arrive at the Rateable Value appear to be insufficient or excessive.

In forming an estimate for the Metropolitan Boroughs it must be borne in mind that in several Parishes the Gross Estimated Rental of Compounded Houses is *inclusive* of all Tenants rates, which are paid by the Landlord, and the Rateable Value, instead of being calculated upon the principle laid down by the Parochial Assessment Act, is entered at one half of such gross rent.

Return F.

Poor Rate and Income Tax Assessments.

This Return shows the Gross Estimated Rental and Rateable Value according to the Valuation Lists, or last Poor Rate, of all Rateable Property within the several Parliamentary Boroughs as compared with the Gross Estimated Rental and Rateable Value of the same property at Lady Day 1856; the Gross Estimated Value, according to the last Income Tax Assessment under Schedule A., omitting Mines, Railways, and other properties assessed upon Profits, and the Gross Estimated Rental of the same Property, with a similar omission according to the Valuation Lists or last Poor Rates.

By the aid of this Return a comparison may be instituted between the present system of Assessment to the Poor Rate and that which existed prior to the passing of the Union Assessment Committee Act; and the Valuations upon which the Poor Rate is now based may be tested with the estimate of value arrived at by the Income Tax Commissioners. The most recent Return showing the Gross Estimated Rental, and Rateable Value prior to 1863, is the Return No. 124 (1860), which is taken from the Poor Rate Assessment in existence at Lady Day 1856. A later Return could not have been procured without communicating with the Overseers of each Parish, but this would have occasioned great delay, and it is probable that in some Parishes the Rate Books for 1862 would not have been in their possession.

The Income Tax Returns have been obtained through the Inland Revenue Department.

In order to afford a basis of comparison between the totals of these Returns and the totals of Gross Estimated Rental given in Valuation Lists, it has been necessary to eliminate from the latter the following Rateable Properties, which form the subject of separate charge in the Income Tax Assessment, viz., 1. Railways; 2. Quarries; 3. Mines; 4. Ironworks; 5. Canals; 6. Gasworks, and 7. Docks, Salt Springs, Alum Works, Waterworks, Telegraphs, Tolls, Ferries, and Bridges. But even with these deductions it will be found that in some instances the comparison is not based upon precisely the same data, as the Income Tax Assessment sometimes includes properties which are not rateable to the Poor Rate.

Another difficulty has arisen in consequence of the area of the two assessments not being always the same.

When the discrepancy between the two valuations has been large every effort has been made to correct or explain the variations by means of a conference between the Union Clerks and the Local Surveyors. The explanations which have been obtained upon these points appear in the Borough Summary already referred to.

It may not be irrelevant to remark that the Income Tax Assessment is usually made upon the extreme rack rent paid, without any allowance or deduction, whereas the valuation of the Assessment Committee is based upon an *estimate* of the rent at which the property might *reasonably* be expected to let *communibus annis*.

Borough Summary.

This Summary supplies under the head of each Borough the whole of the particulars contained in the preceding Returns. It also shows the Population in 1861, and the Rateable Value immediately prior to the passing of the Union Assessment Act, which the Union Clerks were enabled to state from the information obtained by them for the purpose of distributing the common charges over the property in the several Parishes of the Union, in conformity with the 24 & 25 Vict. c. 55., which was passed on 1st August 1861.

The Summary also gives a short abstract of the Local Acts in force in particular Boroughs for rating Owners instead of Occupiers. It states whether the Gross Estimated Rental represents the full rack rent, and shows the scale of deductions adopted in estimating the Rateable Value of Houses at and under 10*l.*

It also contains explanations of the discrepancies which appear on the face of some of the other Returns.

The Total of the Male Occupations in each Borough at a Gross Estimated Rental is given for the purpose of comparison with the number of Inhabited Houses in 1861.

Return G.

COUNTIES.

Population, Male Occupiers, and Electors.

This Return gives the Population in 1831 and 1861; the Number of Male Occupiers of a house or building, with or without land, at various *rateable* values, commencing at 10*l* and extending to 50*l.*; the Number of such Persons who are Owners of the Property occupied by them; the Number of Occupiers of Lands or Tenements at a gross estimated Rental of 50*l.* and upwards, with the Number of such Occupiers who are Owners also, and the Number of Electors on the Register 1864–5 as Occupying Tenants at 50*l.* and upwards; the Gross Estimated Rental and Rateable Value of the Property in each County or Electoral Division prior and subsequent to the passing of the Union Assessment Committee Act, and the Total Number of Electors on the Registers for the Years 1832–3 and 1864–5.

The Population Returns are taken from the Parliamentary Paper, No. 283 (1864).

The Occupation Statistics have been extracted from the Valuation Lists or Poor Rates through the same agency as that which was employed in obtaining the Borough Returns.

It should be observed that the Union Assessment Committee Act is almost universally in force in the Counties, there being only about twelve Local Incorporations, chiefly under Gilbert's Act, and some few separate Parishes which have not adopted or are not within its provisions.

The population and area of these places are comparatively so small as to be unimportant. When therefore the Valuation Lists are complete they will include, with these exceptions, all the county constituencies of England and Wales. At present eight ninths of the Valuation Lists are complete, and the remainder, although not finally approved, are in a state of great forwardness.

The instructions given for the preparation of this part of the Return, so far as it relates to the number of Male Occupiers at 10*l.* and under 50*l.*, *Rateable Value*, are the same in effect, *mutatis mutandis*, as those already quoted with respect to Boroughs.

Occupiers of a house or building with or without land were the only ones to be counted. Where the same person was assessed for several properties he was to be entered but once, and then for the Property of the highest value, and all Persons occupying Property within the boundary of a Parliamentary Borough only were to be excluded.

It was intended to guard as far as possible against double entries in the same County or Electoral Division; but although the Union Clerks are able to check the double occupations in one or more parishes of the same Union, they cannot do the same in cases where the same Persons occupy Property in different Unions.

In estimating the Number of Male Occupations at 50*l*, and upwards, Occupiers of Land only, without any Building upon it, were to be included, and the Gross Estimated Rental was to form the basis of the Return, instead of the Rateable Value.

Supplemental Instructions were issued stating that the Object of this section of the Return is " To show the Number of Occupiers who might be " entitled to be placed on the Parliamentary Register as 50*l.* Occupiers of " Land or Tenements under the existing County Franchise;" and further that, When an Occupier is assessed at a Gross Estimated Rental of 50*l.* and upwards, and at a Rateable Value below that Amount, he must be included in the Column intended for the former class, and not amongst the Occupations at a Rateable Value.

It will be observed that with regard to the Occupations at Rateable Values under 50*l.*, those persons only were to be included who occupy a house or other building, with or without land, or, in other words, property of the description required in the case of the existing Occupation Franchise in Boroughs.

With regard to the Occupations at and over 50*l.* Gross Estimated Rental, the Male Occupiers of lands or tenements of every description were to be included, in order that a comparison might be made between the actual Number of Electors on the Register as possessing the existing 50*l.* Franchise and the total Number of Persons who appear to be entitled to it.

The Number of Electors on the Register, 1864–5, is taken from the Parliamentary Return, No. 448, 1865. This course was adopted in consequence of the late period at which some of the County Registers are printed;

but it is not likely that any material variation will be found between the Registers of last year and those of the present one.

For the reason already given in the explanation of the Borough Returns, the Parliamentary Return, No. 131, 1860, has been adopted for the purpose of showing the Gross Estimated Rental and Rateable Value of the property in each County and Electoral Division prior to the passing of the Union Assessment Committee Act.

Appended to the Return G. is an abstract showing the net number of Male Occupiers, exclusive, in all cases, of those who are both Owners and Occupiers.

At the end of the Returns will be found a List of some of the principal Parliamentary Papers relating to Electoral Statistics since the passing of the Reform Act. This List has been added for the convenience of reference.

Poor Law Board,
28th February 1866.

JOHN LAMBERT,
Poor Law Inspector.
(Appointed to superintend the collection and arrangement of the Returns.)

Return A.

PARLIAMENTARY BOROUGHS:—Population and Number of Electors.

A Return showing, in respect of the several Parliamentary Boroughs in England and Wales, the Increase or Decrease between the Population in 1831 and the estimated Population in 1866; the Increase or Decrease between the Total Number of Electors on the Register for 1832–3 and the Register for 1865–6; the present actual Number of Electors, after deducting double Entries; and the Number of Electors who voted at the last General Election.

Name of City or Borough.	Population, 1831.*	Population (Estimated), 1866.†	Increase.	Decrease.	Total Number of Electors on Register, 1832–3.‡	Total Electors on Register, 1865–6.	Increase.	Decrease.	Present actual Number of Electors, after deducting double Entries.	Number of Electors who voted at the last General Election.
ENGLAND.										
1. Abingdon - -	5,259	5,548	289	—	300§ S. & L. 300	329 S. & L. 20	29	—	304	235
2. Andover - - -	4,966	5,448	482	—	246 F. 17	263 F. 3	17	—	255	No contest.
3. Arundel - -	2,803	2,382	—	421	351 S. & L. 351	174 S. & L. 31	—	177	174	No contest.
4. Ashburton - -	4,165	2,892	—	1,273	198 A. R. 52	356 A. R. 3	158	—	350	No contest.
5. Ashton-under-Lyne -	14,035	36,190	22,155	—	433	967	534	—	967	No contest.
6. Aylesbury - -	23,434	27,239	3,805	—	1,654 S. & L. 276	1,329 S. & L. 103	—	325	1,225	No contest.
7. Banbury - -	6,411	11,061	4,650	—	339 F. 13	763	424	—	614	531
8. Barnstaple - -	9,272	10,442	1,170	—	720 F. 261 S. & L. 459	763 F. 182	43	—	715	634
9. Bath - - -	50,800	51,692	892	—	‖ 2,853 A. R. 19	3,236 A. R. 1	383	—	2,960	No contest.
10. Bedford - - -	6,959	14,366	7,407	—	1,572 F. 597 A. R. 975	1,108 F. 45 A. R. 133	—	464	1,106	955
11. Berwick-upon-Tweed -	13,129	12,435	—	694	705 F. 436 S. & L. 269	816 F. 376	111	—	731	675
12. Beverley - - -	8,263	11,297	3,034	—	1,011 F. 865	1,474 F. 855	463	—	1,239	1,108
13. Bewdley - -	7,939	6,970	—	969	337 A. R. 25	361 A. R. 5	24	—	356	No contest.
14. Birkenhead - -	4,195	60,604	56,409	—	New Borough	4,563	4,563	—	4,563	3,181
15. Birmingham - -	143,986	333,868	189,882	—	4,309	15,497	11,188	—	14,997	No contest.
16. Blackburn - -	27,091	73,522	46,431	—	626	1,894	1,268	—	1,894	1,733
17. Bodmin - - -	5,228	6,403	1,175	—	252 A. R. 30	403 A. R. 2	151	—	397	347

* The population in 1831 is taken from Parliamentary Return No. 283 (1864).

† The Registrar-General states that there are no authentic materials in his hands from which he can estimate the probable population of each borough on the completion of the fifth year since the last Census, namely, on 8th April 1866. The estimated numbers given as the population in 1866 are derived from the ascertained ratio of increase or decrease in each case between 1851 and 1861. The increase or decrease is assumed to proceed in a geometrical progression; thus the enumerated population of Manchester was 316,213 in 1851, and 357,979 in 1861; consequently the annual rate of increase was 1·248 per cent., and if the population increased at the same rate after 1861 it would amount, on 8th April 1866, to 380,887. The same method is employed in all the other calculations. The results thus obtained can be correct only where the ratio of increase or decrease from 1861 to 1866 was the same as between 1851 and 1861. In many cases the numbers given will approximate to the truth, but in others they must be entirely erroneous.

‡ The total number of Electors, as given in this return, is *inclusive* of double entries. This course is adopted in consequence of the return for 1832–3, Parliamentary Return No. 189 (1833), not distinguishing double entries, except in a few instances. The number of Freemen, Scot and Lot Voters, and Electors possessing other ancient-right qualifications, are included in the totals, but the number so included is shown under each total. F. indicates Freemen, S. and L. Scot and Lot Voters, and A. R. other Ancient-Right qualifications.

§ In this and several other instances the £10 occupiers are not distinguished in the Return No. 189 (1833) from the Scot and Lot Voters, but all the Electors are returned under the latter qualification, although a large number of them must have been £10 occupiers also.

‖ The qualifications of the Electors are not distinguished in the Return No. 189 (1833), and the number of Electors in respect of Ancient-Right Qualifications is for 1836–7 taken from the Return No. 329, 1838.

NAME OF CITY OR BOROUGH.	Population, 1831.	Population (Estimated), 1866.	Increase.	Decrease.	Total Number of Electors on Register, 1832–3.	Total Electors on Register, 1865–6.	Increase.	Decrease.	Present actual Number of Electors, after deducting double Entries.	Number of Electors who voted at the last General Election.
18. BOLTON - - -	42,245	75,516	33,271	—	1,040	2,293	1,253	—	2,186	1,887
19. BOSTON - - -	12,798	18,084	5,286	—	885 F. 372	1,093 F. 148	208	—	1,021	966
20. BRADFORD - - -	43,527	107,459	63,932	—	1,139	5,189	4,050	—	5,189	No contest.
21. BRIDGNORTH - -	6,517	7,744	1,227	—	* 746 F. 566	658 F. 277	—	88	614	534
22. BRIDGWATER - -	7,279	11,857	4,578	—	484 S. & L. 132	679 S. & L. 41	195	—	644	557
23. BRIDPORT - - -	6,684	7,797	1,113	—	433 S. & L. 322	503 S. & L. 28	70	—	472	No contest.
24. BRIGHTON - - -	41,994	97,750	55,756	—	1,649	6,352	4,703	—	5,978	About 4,990
25. BRISTOL - - -	104,408	163,228	58,820	—	* 10,315 F. 5,309 A. R. 1,303	14,324 F. 1,707 A. R. 1,920	4,009	—	11,303	9,400
26. BUCKINGHAM - -	7,418	7,414	—	4	312 F. 12	407 F. 2	95	—	391	296
27. BURY - - -	19,140	41,175	22,035	—	535	1,366	831	—	1,352	1,167
28. BURY ST. EDMUNDS -	11,436	13,036	1,600	—	620 F. 30	697 F. 8	77	—	676	620
29. CALNE - - -	4,795	5,171	376	—	191 A. R. 15	175 A. R. 3	—	16	174	No contest.
30. CAMBRIDGE - -	20,917	25,663	4,746	—	1,499 F. 79	1,926 F. 21	427	—	1,769	1,497
31. CANTERBURY - -	16,112	22,957	6,845	—	1,511 F. 1,209	1,808 F. 724	297	—	1,603	1,385
32. CARLISLE - - -	18,865	31,106	12,241	—	977 F. 406 S. & L. 571	1,506 F. 310	529	—	1,304	1,195
33. CHATHAM - - -	21,124	40,814	19,690	—	677	2,111	1,434	—	2,104	1,691
34. CHELTENHAM - -	22,942	42,240	19,298	—	919	2,793	1,874	—	2,793	2,286
35. CHESTER - - -	21,344	32,930	11,586	—	2,028 F. 1,379 S. & L. 649	2,700 F. 1,102	672	—	2,274	2,146
36. CHICHESTER - -	7,356	7,773	417	—	852 F. 64 S. & L. 285	587 F. 2 S. & L. 26	—	265	562	No contest.
37. CHIPPENHAM - -	5,270	7,508	2,238	—	208 F. 96	407 F. 5	199	—	392	362
38. CHRISTCHURCH - -	6,077	10,487	4,410	—	206 A. R. 13	419	213	—	419	354
39. CIRENCESTER - -	5,420	6,460	1,040	—	*604 A. R. 483	464 A. R. 48	—	140	464	403
40. CLITHEROE - -	9,890	10,569	679	—	306 F. 18	484	178	—	438	No contest.
41. COCKERMOUTH - -	6,022	6,950	928	—	305	356	51	—	336	No contest.
42. COLCHESTER - -	16,167	26,347	10,180	—	1,099 F. 476 S. & L. 623	1,424 F. 405	325	—	1,405	1,245
43. COVENTRY - - -	27,298	44,298	17,000	—	3,285 F. 2,756	4,967 F. 3,911	1,682	—	4,967	4,791
44. CRICKLADE - - -	28,494	37,608	9,114	—	* 1,534 A. R. 716	2,094 A. R. 86	560	—	2,029	1,637
45. DARTMOUTH - -	4,597	4,412	—	185	243 F. 22	295 F. 1	52	—	282	No contest.

* The qualifications of the Electors not being distinguished in the Return No. 189 (1833), the number of Freemen or other Voters in respect of Ancient-Right Qualifications not specified in that Return is the number given for 1836–7 in the Return No. 329 (1838).

NAME OF CITY OR BOROUGH.	Population, 1831.	Population (Estimated), 1866.	Increase.	Decrease.	Total Number of Electors on Register, 1832–3.	Total Electors on Register, 1865–6.	Increase.	Decrease.	Present actual Number of Electors, after deducting double Entries.	Number of Electors who voted at the last General Election.
46. DERBY - - -	23,627	44,388	20,761	—	1,384 F. 372	2,532 F. 336	1,148	—	2,450	2,120
47. DEVIZES - - -	6,367	6,680	313	—	336 A. R. 23	369 A. R. 4	33	—	359	190
48. DEVONPORT - -	44,454	73,624	29,170	—	1,777	2,860	1,083	—	2,820	2,582
49. DORCHESTER - - -	4,940	7,048	2,108	—	*322 A. R. 14	451	129	—	432	387
50. DOVER - - -	15,645	27,022	11,377	—	1,651 F. 1,284	2,414 F. 839	763	—	2,318	1,944
51. DROITWICH - -	5,949	7,081	1,132	—	243 F. 7	400 F. 2	157	—	400	No contest.
52. DUDLEY - - -	23,430	48,953	25,523	—	670	1,358	688	—	1,358	801
53. DURHAM - - -	10,135	14,561	4,426	—	806 F. 492	1,149 F. 501	343	—	1,056	No contest.
54. EVESHAM - -	3,991	4,718	727	—	359 F. 164	372 F. 49	13	—	337	267
55. EXETER - - -	33,552	42,290	8,738	—	2,952 F. 586	3,689 F. 898 A. R. 1,013†	737	—	3,088	No contest.
56. EYE - - -	7,015	6,804	—	211	253 F. 53	346 F. 17	93	—	339	No contest.
57. FINSBURY - - -	234,629	423,560	188,931	—	10,309	25,491	15,182	—	25,461	13,127
58. FROME - - -	10,370	9,224	—	1,146	322	414	92	—	414	389
59. GATESHEAD - -	15,617	38,495	22,878	—	454	1,172	718	—	1,165	No contest.
60. GLOUCESTER - -	13,000	16,006	3,006	—	1,527 F. 725	1,846 F. 548	319	—	1,715	1,500
61. GRANTHAM - -	7,427	11,247	3,820	—	698 F. 496	886 F. 215	188	—	755	676
62. GREENWICH - - -	63,172	160,086	96,914	—	2,714	9,813	7,099	—	9,805	10,824 votes recorded.
63. GRIMSBY, GREAT - -	6,589	16,689	10,100	—	656 F. 353	1,358 F. 346	702	—	1,273	1,056
64. GUILDFORD - - -	5,286	8,748	3,462	—	*342 F. 67 S. & L. 95	725 F. 31 S. & L. 9	383	—	667	581
65. HALIFAX - - -	21,552	38,859	17,307	—	536	1,788	1,252	—	1,771	No contest.
66. HARWICH - - -	4,297	5,411	1,114	—	214 F. 16	389	175	—	386	306
67. HASTINGS - - -	10,097	26,587	16,490	—	574 F. 20 S. & L. 554	1,941 F. 3	1,367	—	1,871	1,438
68. HELSTON - - -	7,115	9,150	2,035	—	341 F. 60	363 F. 6	22	—	348	298
69. HEREFORD - -	10,934	17,682	6,748	—	920 F. 461	1,314 F. 185	394	—	1,215	986
70. HERTFORD - - -	5,860	6,853	993	—	*849 F. 243 S. & L. 205	602 F. 96 S. & L. 10	—	247	543	No contest.
71. HONITON - - -	3,509	3,240	—	269	511 A. R. 480 S. & L. 31	288 A. R. 60	—	223	267	249
72. HORSHAM - - -	5,105	7,186	2,081	—	257 A. R. 7	400	143	—	400	323
73. HUDDERSFIELD - -	19,035	37,066	18,031	—	608	2,138	1,530	—	2,138	1,806
74. HUNTINGDON - - -	5,413	6,272	859	—	*384 F. 71	408 F. 45	24	—	383	No contest.

* The qualifications of the Electors not being distinguished in the Return No. 189 (1833), the number of Freemen or other Voters in respect of Ancient-Right Qualifications not specified in that Return is the number given for 1836–7 in the Return No. 329 (1838).

† These Ancient-Right Qualifications are described as Freeholders. No such class is specified in the Return of 1833.

NAME OF CITY OR BOROUGH.	Population, 1831.	Population (Estimated), 1866.	Increase.	Decrease.	Total Number of Electors on Register, 1832–3.	Total Electors on Register, 1865–6.	Increase.	Decrease.	Present actual Number of Electors, after deducting double Entries.	Number of Electors who voted at the last General Election.
75. HYTHE - - -	8,911	27,222	18,311	—	469 F. 51	1,313 F. 48	844	—	1,291	No contest.
76. IPSWICH - - -	20,201	40,750	20,549	—	1,219 F. 344	2,237 F. 360	1,018	—	2,118	1,839
77. IVES, ST. - - -	7,115	10,602	3,487	—	593 S. & L. 454	536 S. & L. 88	—	57	486	410
78. KENDAL - - -	11,577	12,130	553	—	327	454	127	—	439	No contest.
79. KIDDERMINSTER - -	16,000	14,064	—	1,936	390	625	235	—	612	555
80. KINGS LYNN - -	13,370	14,780	1,410	—	836 F. 253	901 F. 96	65	—	852	749
81. KINGSTON-UPON-HULL -	51,911	104,873	52,962	—	4,320 F. 1,656	6,498 F. 1,358	2,178	—	5,566	4,671
82. KNARESBOROUGH - -	5,936	5,336	—	600	278	290	12	—	272	247
83. LAMBETH - - -	154,613	319,403	164,790	—	4,768	27,754	22,986	—	27,754	17,910 votes for 4 candidates.
84. LANCASTER - - -	14,066	15,924	1,858	—	1,109 F. 848	1,473 F. 1,006	364	—	1,465	1,339
85. LAUNCESTON - - -	5,414	4,755	—	659	243 F. 12	421	178	—	371	No contest.
86. LEEDS - - -	123,393	227,180	103,787	—	Upwards of 4,000	8,485	About 4,485	—	7,217	6,088
87. LEICESTER - - -	40,639	72,131	31,492	—	3,526 F. 2,070 S. & L. 256	5,438 F. 1,839 S. & L. 11	1,912	—	4,762	4,121
88. LEOMINSTER - -	5,249	5,894	645	—	779 S. & L. 756 A. R. 23	408 S. & L. 52 A. R. 4	—	371	367	312
89. LEWES - - -	9,027	9,809	782	—	878 S. & L. 690	720 S. & L. 56	—	158	676	604
90. LICHFIELD - - -	6,499	6,834	335	—	* 861 F. 205 A. R. 379	720 F. 95 A. R. 211	—	141	564	768 votes recorded.
91. LINCOLN - - -	11,217	22,979	11,762	—	1,043 F. 582	1,813 F. 546	770	—	1,713	1,554
92. LISKEARD - - -	4,094	6,784	2,690	—	218 F. 23	450	232	—	434	No contest.
93. LIVERPOOL - - -	201,751	482,409	280,658	—	11,283 F. 3,628	21,839 F. 1,285	10,556	—	20,618	22,526 votes recorded.
94. LONDON - - -	122,531	104,908	—	17,623	18,584 F. 9,527	17,534 F. 5,514	—	1,050	15,534	10,997
95. LUDLOW - - -	5,870	6,391	521	—	359 F. 59 S. & L. 300	426 F. 31	67	—	400	338
96. LYME REGIS - -	3,345	3,074	—	271	222 F. 14	252 F. 2	30	—	250	223
97. LYMINGTON - -	5,361	5,128	—	233	249	349	100	—	347	272
98. MACCLESFIELD - -	30,408	34,712	4,304	—	718	964	246	—	861	838
99. MAIDSTONE - -	15,790	24,277	8,487	—	1,108 F. 456	1,973 F. 401	865	—	1,817	1,696
100. MALDON - -	4,895	6,456	1,561	—	*716 F. 699	904 F. 596	188	—	859	799
101. MALMESBURY - -	6,136	6,823	687	—	291 F. 13	370 F. 13	79	—	329	293
102. MALTON - -	6,802	8,286	1,484	—	667 S. & L 292	603 S. & L. 11	—	64	600	No contest.

* The qualifications of Electors not being distinguished in the Return No. 189 (1833), the number of Freemen or other Voters in respect of Ancient-Right Qualifications not specified in that Return is the number given for 1836–7 in the Return No. 329 (1838).

Name of City or Borough.	Population, 1831.	Population (Estimated), 1866.	Increase.	Decrease.	Total Number of Electors on Register, 1832–3.	Total Electors on Register, 1865–6.	Increase.	Decrease.	Present actual Number of Electors, after deducting double Entries.	Number of Electors who voted at the last General Election.
103. Manchester	187,022	380,887	193,865	—	6,726	22,792	16,066	—	21,542	14,916
104. Marlborough	4,186	4,776	590	—	* 280 F. 8	304 F. 1	24	—	275	No contest.
105. Marlow, Great	6,175	6,483	308	—	457 S. & L. 362	354 S. & L. 25	—	103	349	No contest.
106. Marylebone	240,294	473,091	232,797	—	8,901	23,888	14,987	—	23,588	11,067
107. Midhurst	5,627	6,118	491	—	252 S. & L. 252	362	110	—	309	No contest.
108. Monmouth	13,585	32,838	19,253	—	* 1,169 F. 206	2,146 F. 21	977	—	2,087	No contest.
109. Morpeth	6,766	16,191	9,425	—	321 F. 131	485 F. 96	164	—	448	No contest.
110. Newark	9,557	11,609	2,052	—	1,575 S. & L. 1,575	711 S. & L. 171	—	864	710	No contest.
111. Newcastle-under-Lyme	8,192	14,315	6,123	—	973 F. 842	1,181 F. 718	208	—	1,077	891
112. Newcastle-upon-Tyne	53,613	121,640	68,027	—	3,905 F. 1,619	7,460 F. 1,842	3,555	—	6,630	4,746
113. Newport (Isle of Wight)	6,700	7,878	1,178	—	425 F. 15	664 F. 2	239	—	643	547
114. Northallerton	4,839	4,639	—	200	‡ 257	454 A. R. 2	197	—	442	429
115. Northampton	15,351	36,405	21,054	—	2,497 S. & L. 2,497	2,857 S. & L. 278	360	—	2,620	2,284
116. Norwich	61,116	78,185	17,069	—	4,238 F. 2,420 A. R. 775	5,682 F. 1,971 A. R. 1,272	1,444	—	4,817	3,457
117. Nottingham	50,220	85,200	34,980	—	* 5,220 F. 3,033 A. R. 598	6,921 F. 1,565 A. R. 1,027	1,701	—	5,934	9,314
118. Oldham	50,513	107,729	57,216	—	1,131	2,316	1,185	—	2,285	1,993
119. Oxford	20,649	27,420	6,771	—	2,312 F. 1,408	3,113 F. 951	801	—	2,594	No contest.
120. Penryn and Falmouth	11,881	14,918	3,037	—	875 S. & L. 475	887 S. & L. 71	12	—	837	No contest.
121. Peterborough	6,511	13,651	7,140	—	773 S. & L. 488	653 S. & L. 44	—	120	641	601
122. Petersfield	4,391	5,708	1,317	—	255	323	68	—	296	No contest.
123. Plymouth	31,080	68,538	37,458	—	1,461 F. 115	3,123 F. 14	1,662	—	2,944	2,400
124. Poole	8,216	10,021	1,805	—	412 F. 111	568 F. 12	156	—	521	414
125. Pontefract	9,999	11,848	1,849	—	956 S. & L. 538	732 S. & L. 80	—	224	699	602
126. Portsmouth	50,389	108,705	58,316	—	1,295 F. 15	4,671 F. 1	3,376	—	4,670	3,662
127. Preston	33,871	90,652	56,781	—	6,352 † A. R. 6,291	2,649 A. R. 425	—	3,703	2,562	No contest.
128. Reading	15,595	27,059	11,464	—	1,001 S. & L. 1,001	1,832 S. & L. 2	831	—	1,769	1,184
129. Reigate	3,397	14,193	10,796	—	152	926	774	—	920	760
130. Retford, East	40,880	47,981	7,101	—	2,312 F. 138 * A. R. 778	2,537 F. 64 A. R. 75	225	—	2,489	No contest.
131. Richmond	4,722	5,219	497	—	*273 A. R. 21	318 A. R. 6	45	—	316	No contest.

* The qualifications of Electors not being distinguished in the Return No. 189 (1833), the number of Freemen or other Voters in respect of Ancient Right Qualifications not specified in that Return is the number given for 1836–7 in the Return No. 329 (1838).

† The old right of election was in the "Inhabitants at large," which was understood as meaning all persons who had resided within the Township of Preston for six months.

‡ The qualifications of the Electors are not distinguished either in the Return of 1833 or 1838.

Name of City or Borough.	Population, 1831.	Population (Estimated), 1866.	Increase.	Decrease.	Total Number of Electors on Register, 1832–3.	Total Electors on Register, 1865–6.	Increase.	Decrease.	Present actual Number of Electors, after deducting double Entries.	Number of Electors who voted at the last General Election.
132. Ripon - - -	5,700	6,219	519	—	*341 S. & L. — A. R. 42	349	8	—	348	328
133. Rochdale - -	19,041	43,668	24,627	—	687	1,442	755	—	1,358	No contest.
134. Rochester - - -	10,585	17,915	7,330	—	1,073 F. 523	1,599 F. 374	526	—	1,458	1,221
135. Rye - - -	7,360	8,038	678	—	422 F. 40 S. & L. 382	392 F. 4	—	30	373	352
136. Salford - - -	50,810	112,403	61,593	—	1,497	5,458	3,961	—	5,397	3,706
137. Salisbury - -	11,672	12,601	929	—	576 A. R. 37	704 A. R. 2	128	—	691	556
138. Sandwich - - -	12,183	14,301	2,118	—	916 F. 429	1,069 F. 228	153	—	1,054	876
139. Scarborough - -	8,760	21,921	13,161	—	*431 F. 32	1,446 F. 9	1,015	—	1,351	1,158
140. Shaftesbury - -	8,969	8,780	—	189	634 S. & L. 338	506 S. & L. 30	—	128	461	No contest.
141. Sheffield - - -	91,692	216,620	124,928	—	3,508	9,136	5,628	—	8,557	5,911
142. Shoreham, New - -	25,008	33,708	8,700	—	1,925 S. & L. 189 A. R. 701	1,999 S. & L. 93	74	—	1,978	1,454
143. Shrewsbury - -	21,297	23,519	2,222	—	1,714 F. 891	1,777 F. 406	63	—	1,553	No contest.
144. Southampton - -	19,324	54,159	34,835	—	* 1,403 F. 37 S. & L. 573	4,230 F. 4 S. & L. 79	2,827	—	4,189	3,382
145. South Shields - -	18,756	38,863	20,107	—	475	1,211	736	—	1,113	No contest.
146. Southwark - -	134,117	204,872	70,755	—	*4,775 S. & L. 1,555	11,646 S. & L. 71	6,871	—	11,631	No contest.
147. Stafford - -	7,583	12,899	5,316	—	1,176 F. 983	1,639 F. 973	463	—	1,540	1,253
148. Stamford - -	7,062	7,638	576	—	*851 S. & L. 360	527 S. & L. 43	—	324	512	No contest.
149. Stoke-upon-Trent -	51,589	111,072	59,483	—	1,349	3,204	1,855	—	3,189	2,690
150. Stockport - -	41,000	55,109	14,109	—	1,012	1,391	379	—	1,348	1,294
151. Stroud - - -	39,932	35,019	—	4,913	1,247	1,400	153	—	1,356	1,057
152. Sunderland - -	40,735	96,805	56,070	—	1,378	3,468	2,090	—	3,468	2,622
153. Tamworth - -	7,182	11,060	3,878	—	586 S. & L. 424	560 S. & L. 31	—	26	532	454
154. Taunton - - -	12,148	14,919	2,771	—	949 A. R. 361	897 A. R. 54	—	52	839	756
155. Tavistock - - -	5,602	9,270	3,668	—	247 A. R. 38	427 A. R. 3	180	—	426	395
156. Tewkesbury - -	5,780	5,875	95	—	*386 F. 91 A. R. 142	342 F. 21 A. R. 9	—	44	325	321
157. Thetford - -	3,462	4,276	814	—	146 A. R. 22	237 A. R. 5	91	—	224	216
158. Thirsk - - -	4,672	5,366	694	—	254	383	129	—	380	No contest.
159. Tiverton - -	9,766	10,115	349	—	462 F. 19	465 F. 4	3	—	465	441

* The qualifications of the Electors not being distinguished in the Return No. 189 (1833), the number of Freemen or other Voters in respect of Ancient-Right Qualifications not specified in that Return is the number given for 1836–7 in the Return No. 329 (1838).

Name of City or Borough.	Population, 1831.	Population (Estimated), 1866.	Increase.	Decrease.	Total Number of Electors on Register, 1832-3.	Total Electors on Register, 1865-6.	Increase.	Decrease.	Present actual Number of Electors, after deducting double Entries.	Number of Electors who voted at the last General Election.
160. Totnes	3,308	3,807	499	—	217 F. 42	395 F. 6	178	—	382	364
161. Tower Hamlets	361,783	710,179	348,396	—	9,906	34,115	24,209	—	34,115	No contest.
162. Truro	8,291	11,652	3,361	—	405 F. 17	640 F. 1	235	—	567	No contest.
163. Tynemouth	23,206	36,741	13,535	—	760	1,271	511	—	1,271	932
164. Wakefield	15,932	23,717	7,785	—	722	1,188	466	—	1,086	964
165. Wallingford	7,352	7,662	310	—	453 S. & L. 166	379 S. & L. 5	—	74	357	290
166. Walsall	14,420	45,788	31,368	—	597	1,296	699	—	1,296	No contest.
167. Wareham	5,596	6,446	850	—	389 S. & L. 152 A. R. 19	298 S. & L. 13	—	91	273	234
168. Warrington	18,184	28,940	10,756	—	456	779	323	—	768	No contest.
169. Warwick	9,109	10,374	1,265	—	1,340 S. & L. 1,340	766 S. & L. 125	—	574	690	607
170. Wells	4,603	4,605	2	—	358 F. 163	296 F. 66	—	62	274	No contest.
171. Wenlock	17,435	22,109	4,674	—	691 S. & L. 489 F. 202	993 F. 142	302	—	961	No contest.
172. Westbury	7,324	6,243	—	1,081	185	300	115	—	300	No contest.
173. Westminster	206,547	261,389	54,842	—	* 11,576 S. & L. 6,656	12,817 S. & L. 431	1,241	—	12,546	12,883 votes given.
174. Weymouth	8,439	12,488	4,049	—	* 475 S. & L. 52	938 F. 4 S. & L. 3	463	—	906	558
175. Whitby	10,399	12,620	2,221	—	422	761	339	—	703	587
176. Whitehaven	15,716	18,805	3,089	—	458	648	190	—	648	No contest.
177. Wigan	20,774	40,889	20,115	—	483 A. R. 60	865 A. R. 3	382	—	863	No contest.
178. Wilton	7,753	8,682	929	—	214 F. 17	273	59	—	265	No contest.
179. Winchester	9,292	15,343	6,051	—	531 F. 66	991 F. 3	460	—	963	779
180. Windsor	7,071	9,482	2,411	—	507 S. & L. 507	657	150	—	651	603
181. Wolverhampton	67,514	163,985	96,471	—	1,700	4,891	3,191	—	4,830	1,618
182. Woodstock	7,115	7,750	635	—	317 F. 76	296 F. 16	—	21	286	262
183. Worcester	25,659	33,259	7,600	—	2,366 F. 1,512 S. & L. 854	2,676 F. 732	310	—	2,309	2,005
184. Wycombe	6,299	9,043	2,744	—	298 F. 28	553 F. 2	255	—	551	No contest.
185. Yarmouth	24,535	36,959	12,424	—	1,683 F. 1,040	1,650	—	33	1,645	1,432
186. York	28,244	48,128	19,884	—	2,873 F. 2,342	4,724 F. 2,571	1,851	—	4,277	3,828
Total for **ENGLAND**	5,013,328	8,944,148	3,963,697	32,877	271,089	499,668	238,838	10,259	475,009	287,463

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* The qualifications of the Electors not being distinguished in the Return No. 189 (1833), the number of Freemen or other Voters in respect of Ancient-Right Qualifications not specified in that Return is the number given for 1836-7 in the Return No. 329 (1838).

Name of City or Borough.	Population, 1831.	Population (Estimated), 1866.	Increase.	Decrease.	Total Number of Electors on Register, 1832–3.	Total Electors on Register, 1865–6.	Increase.	Decrease.	Present actual Number of Electors, after deducting double Entries.	Number of Electors who voted at the last General Election.
WALES.										
187. Beaumaris - -	10,687	13,544	2,857	—	* 329 F. 13	563 F. 2	234	—	558	No contest.
188. Brecon - - -	5,296	5,435	139	—	242 F. 11	293	51	—	281	No contest.
189. Cardiff - -	8,240	46,884	38,644	—	687 F. 454	2,123 F. 234	1,436	—	2,072	No contest.
190. Cardigan - -	10,003	11,589	1,586	—	1,030 F. 564	692 F. 55	—	338	685	No contest.
191. Carmarthen - -	14,340	22,635	8,295	—	† 684 F. 280 S. & L. 404	816 F. 41	132	—	791	No contest.
192. Carnarvon - -	16,288	23,264	6,976	—	*855 S. & L. 495	1,093 S. & L. 66	238	—	1,070	No contest.
193. Denbigh - -	15,616	18,561	2,945	—	1,131 F. 781	934 F. 129	—	197	903	No contest.
194. Flint - - -	16,126	18,861	2,735	—	* 1,359 S. & L. 763	700 S. & L. 99	—	659	689	No contest.
195. Haverfordwest -	8,359	9,867	1,508	—	723 F. 184 S. & L. 539	812 F. 191 S. & L. 215	89	—	669	549
196. Merthyr Tydfil -	27,281	96,717	69,436	—	502	1,387	885	—	1,387	No contest.
197. Montgomery - -	17,272	18,111	839	—	723 F. 66	1,015 F. 61	292	—	965	809
198. Pembroke - -	11,150	24,861	13,711	—	1,208 F. 867	1,479 F. 377	271	—	1,433	972
199. Radnor - -	6,400	7,344	944	—	529 F. 276	444 F. 24	—	85	441	No contest.
200. Swansea - -	27,134	64,888	37,754	—	1,307 F. 481	2,007 F. 312	700	—	1,967	No contest.
Total for WALES	194,192	382,561	188,369	—	11,309	14,358	4,328	1,279	13,911	2,330
Total for ENGLAND AND WALES	5,207,520	9,326,709	4,152,066	32,877	282,398	514,026	243,166†	11,538	488,920	289,793‡

* Qualifications of Electors not being distinguished in the Return No. 189 (1833), the number of Freemen or other Voters in respect of Ancient-Right Qualifications not specified in that Return is the number given for 1836–7 in the Return No. 329 (1838).

† These numbers are taken from the Register 1864–5, the Register for the present year not having been printed when the Return was applied for.

‡ This total, it will be observed, includes in some cases the votes recorded when the number of voters could not be given.

Total Number of Electors on the Register 1865–6, including double entries	**514,026**	
Total Number on the Register 1832–3 - - - -	**282,398**	
Increase - - - - - - -	**231,628**	
Total Number of Freemen on the Register 1832–3 - - - -	**63,481**	
Total Number on the Register 1865–6 - - - -	**41,641**	
Decrease - - - - - - - - -		**21,840**
Total Number of Scot and Lot Voters, Potwallers, and Persons (other than Freemen) possessing Ancient-Right Qualifications reserved by 2 Will. 4. c. 45. on the Register 1832–3 - - - - -	**44,738**	
Total Number of such Electors on the Register 1865–6 - - -	**8,837**	
Decrease - - - - - - - -		**35,901**
Total Decrease of Freemen, Scot and Lot Voters, &c. - -		**57,741**

Return B.

BOROUGHS. ELECTORS (Working Classes) RETURN.

A Return showing the Number of Electors on the Parliamentary Register for each City and Borough in England and Wales for 1865–6 classed according to the several Qualifications in respect of which they are entitled to vote, and the Number of such Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour, classed in like manner.

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
ENGLAND.													
1. Abingdon - - -	309	—	20	329	5	20	**304**	59	—	—	59	—	**59**
2. Andover - - -	260	3	—	263	5	3	**255**	15	—	—	15	—	**15**
3. Arundel - - -	143	—	31	174	—	—	**174**	36	—	16	52	—	**52**
4. Ashburton - -	353	—	3	356	4	2	**350**	45	—	—	45	—	**45**
5. Ashton-under-Lyne -	967	—	—	967	—	—	**967**	188	—	—	188	—	**188**
6. Aylesbury - -	1,226	—	103	1,329	43	61	**1,225**	163	—	22	185	1	**184**
7. Banbury - - -	763	—	—	763	149	—	**614**	125	—	—	125	—	**125**
8. Barnstaple - -	581	182	—	763	—	48	**715**	49	77	—	126	2	**124**

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
9. Bath - - -	3,235	—	1	3,236	275	1	2,960	448	—	—	448	—	448
10. Bedford - -	930	45	133	1,108	—	2	1,106	221	1	60	282	—	282
11. Berwick-upon-Tweed -	440	376	—	816	3	82	731	96	221	—	317	11	306
12. Beverley - -	619	855	—	1,474	27	208	1,239	196	589	—	785	123	662
13. Bewdley - -	356	—	5	361	1	4	356	35	—	—	35	—	35
14. Birkenhead - -	4,563	—	—	4,563	—	—	4,563	2,065	—	—	2,065	—	2,065
15. Birmingham - -	15,497	—	—	15,497	500 estimated.	—	14,997	2,895	—	—	2,895	12	2,883
16. Blackburn - -	1,894	—	—	1,894	—	—	1,894	332	—	—	332	—	332
17. Bodmin - - -	401	—	2	403	4	2	397	104	—	—	104	—	104
18. Bolton - -	2,293	—	—	2,293	107	—	2,186	467	—	—	467	—	467
19. Boston - - -	945	148	—	1,093	29	43	1,021	115	84	—	199	2	197
20. Bradford - -	5,189	—	—	5,189	—	—	5,189	438	—	—	438	—	438
21. Bridgnorth - -	381	277	—	658	7	37	614	55	132	—	187	—	187
22. Bridgwater - -	638	—	41	679	—	35	644	281	—	9	290	6	284
23. Bridport - -	475	—	28	503	19	12	472	134	—	11	145	2	143
24. Brighton - -	6,352	—	—	6,352	374	—	5,978	1,978	—	—	1,978	—	1,978
25. Bristol - -	10,697	1,707	1,920	14,324	* 768	* 2,253	* 11,303	3,440	655	256	4,351	300	4,051

* These numbers are estimated upon a comparison of the Lists for certain Parishes and the Lists of Freemen and Freeholders.

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
26. BUCKINGHAM - -	405	2	—	407	14	2	391	10	—	—	10	—	10
27. BURY - - - - -	1,366	—	—	1,366	14	—	1,352	218	—	—	218	—	218
28. BURY ST. EDMUNDS -	689	8	—	697	16	5	676	90	—	—	90	—	90
29. CALNE - - - -	172	—	3	175	—	1	174	7	—	—	7	—	7
30. CAMBRIDGE - - -	1,905	21	—	1,926	143	14	1,769	495	4	—	499	—	499
31. CANTERBURY - -	1,084	724	—	1,808	17	188	1,603	144	372	—	516	1	515
32. CARLISLE - - -	1,196	310	—	1,506	144	58	1,304	148	167	—	315	6	309
33. CHATHAM - - -	2,111	—	—	2,111	7	—	2,104	970	—	—	970	—	970
34. CHELTENHAM - -	2,793	—	—	2,793	—	—	2,793	984	—	—	984	—	984
35. CHESTER - - -	1,598	1,102	—	2,700	170	256	2,274	361	653	—	1,014	27	987
36. CHICHESTER - -	559	2	26	587	15	10	562	143	—	13	156	1	155
37. CHIPPENHAM - -	402	5	—	407	10	5	392	73	—	—	73	—	73
38. CHRISTCHURCH - -	419	—	—	419	—	—	419	77	—	—	77	—	77
39. CIRENCESTER - -	416	—	48	464	—	—	464	77	—	42	119	—	119
40. CLITHEROE - - -	484	—	—	484	46	—	438	64	—	—	64	—	64
41. COCKERMOUTH - -	356	—	—	356	20	—	336	35	—	—	35	1	34

Borough or City.	1. Number of Electors on Register, 1865-6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
42. Colchester - -	1,019	405	—	1,424	12	7	1,405	290	272	—	562	2	560
43. Coventry - - -	1,056	3,911	—	4,967	*	—	4,967	328	3,140	—	3,468	—	3,468
44. Cricklade - -	2,008	—	86	2,094	30	35	2,029	627	—	19	646	3	643
45. Dartmouth - -	294	1	—	295	13	—	282	21	—	—	21	—	21
46. Derby - - -	2,196	336	—	2,532	1	81	2,450	533	174	—	707	18	689
47. Devizes - - -	365	—	4	369	6	4	359	26	—	—	26	—	26
48. Devonport - -	2,860	—	—	2,860	40	—	2,820	1,405	—	—	1,405	8	1,397
49. Dorchester - -	451	—	—	451	19	—	432	152	—	—	152	—	152
50. Dover - - -	1,575	839	—	2,414	5	91	2,318	679	194	—	873	28	845
51. Droitwich - -	398	2	—	400	—	—	400	118	—	—	118	1	117
52. Dudley - - -	1,358	—	—	1,358	—	—	1,358	247	—	—	247	—	247
53. Durham - - -	648	501	—	1,149	23	70	1,056	61	356	—	417	2	415
54. Evesham - - -	323	49	—	372	15	20	337	7	16	—	23	—	23
55. Exeter - - -	1,778	898	1,013	3,689	113	488	3,088	361	113	38	512	—	512

* 608 of the Freemen are £10 Occupiers, although on the Register as Freemen only.

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
56. Eye - - -	329	17	—	346	1	6	**339**	30	—	—	30	2	**28**
57. Finsbury - -	25,491	—	—	25,491	30	—	**25,461**	4,181	—	—	4,181	—	**4,181**
58. Frome - - -	414	—	—	414	—	—	**414**	60	—	—	60	—	**60**
59. Gateshead - -	1,172	—	—	1,172	7	—	**1,165**	110	—	—	110	—	**110**
60. Gloucester - -	1,298	548	—	1,846	43	88	**1,715**	282	199	—	481	33	**448**
61. Grantham - -	671	215	—	886	85	46	**755**	86	67	—	153	2	**151**
62. Greenwich - -	9,813	—	—	9,813	8	—	**9,805**	5,169	—	—	5,169	—	**5,169**
63. Grimsby, Great - -	1,012	346	—	1,358	6	79	**1,273**	215	181	—	396	—	**396**
64. Guildford - -	685	31	9	725	19	39	**667**	227	5	—	232	3	**229**
65. Halifax - - -	1,788	—	—	1,788	17	—	**1,771**	171	—	—	171	—	**171**
66. Harwich - - -	389	—	—	389	3	—	**386**	125	—	—	125	—	**125**
67. Hastings - - -	1,938	3	—	1,941	68	2	**1,871**	807	—	—	807	—	**807**
68. Helston - - -	357	6	—	363	11	4	**348**	57	—	—	57	—	**57**

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
69. HEREFORD - -	1,129	185	—	1,314	31	68	1,215	266	73	—	339	16	323
70. HERTFORD - -	496	96	10	602	10	49	543	158	27	8	193	7	186
71. HONITON - - -	228	—	60	288	—	21	267	69	—	38	107	6	101
72. HORSHAM - -	400	—	—	400	—	—	400	85	—	—	85	—	85
73. HUDDERSFIELD - -	2,138	—	—	2,138	—	—	2,138	268	—	—	268	—	268
74. HUNTINGDON - -	363	45	—	408	3	22	383	12	6	—	18	—	18
75. HYTHE - - -	1,265	48	—	1,313	14	8	1,291	413	15	—	428	—	428
76. IPSWICH - - -	1,877	360	—	2,237	74	45	2,118	131	216	—	347	3	344
77. IVES, ST. - - -	448	—	88	536	6	44	486	189	—	59	248	—	248
78. KENDAL - - -	454	—	—	454	15	—	439	31	—	—	31	—	31
79. KIDDERMINSTER - -	625	—	—	625	13	—	612	104	—	—	104	—	104
80. KINGS LYNN - -	805	96	—	901	12	37	852	127	26	—	153	1	152
81. KINGSTON-UPON-HULL -	5,140	1,358	—	6,498	269	663	5,566	660	349	—	1,009	91	918
82. KNARESBOROUGH - -	290	—	—	290	18	—	272	20	—	—	20	—	20

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
83. Lambeth - - -	27,754	—	—	27,754	—	—	**27,754**	9,501	—	—	9,501	—	**9,501**
84. Lancaster - -	467	1,006	—	1,473	3	5	**1,465**	57	608	—	665	2	**663**
85. Launceston - -	421	—	—	421	50	—	**371**	82	—	—	82	4	**78**
86. Leeds - - -	8,485	—	—	8,485	1,268	—	**7,217**	523	—	—	523	—	**523**
87. Leicester - - -	3,588	1,839	11	5,438	240	436	**4,762**	651	1,273	2	1,926	27	**1,899**
88. Leominster - - -	352	—	56	408	15	26	**367**	47	—	24	71	—	**71**
89. Lewes - - -	664	—	56	720	14	30	**676**	167	—	22	189	3	**186**
90. Lichfield - - -	414	95	211	720	17	139	**564**	121	55	30	206	33	**173**
91. Lincoln - - -	1,267	546	—	1,813	49	51	**1,713**	431	357	—	788	16	**772**
92. Liskeard - - -	450	—	—	450	16	—	**434**	61	—	—	61	—	**61**
93. Liverpool - -	20,554	1,285	—	21,839	840	381	**20,618**	2,476	312	—	2,788	108	**2,680**
94. London, City of - -	12,020	5,514	—	17,534	* 440	* 1,560	**15,534**	1,141	238	—	† 1,379	—	**1,379**
95. Ludlow - - -	395	31	—	426	16	10	**400**	63	2	—	65	—	**65**
96. Lyme Regis - -	250	2	—	252	1	1	**250**	49	—	—	49	—	**49**
97. Lymington - -	349	—	—	349	2	—	**347**	74	—	—	74	—	**74**
98. Macclesfield - -	964	—	—	964	103	—	**861**	80	—	—	80	—	**80**

* Obtained by the Returning Officer from the Election Agents, and he believes it to be correct.

† Obtained from the Election Agents.

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
99. MAIDSTONE	1,572	401	—	1,973	—	156	**1,817**	598	262	—	860	58	**802**
100. MALDON	308	596	—	904	4	41	**859**	54	425	—	479	—	**479**
101. MALMESBURY	357	13	—	370	35	6	**329**	47	—	—	47	—	**47**
102. MALTON	592	—	11	603	3	—	**600**	47	—	9	56	—	**56**
103. MANCHESTER	22,792	—	—	22,792	* 1,250	—	**21,542**	5,822	—	—	5,822	—	**5,822**
104. MARLBOROUGH	503	1	—	304	28	1	**275**	99	—	—	99	—	**99**
105. MARLOW, GREAT	329	—	25	354	3	2	**349**	125	—	22	147	—	**147**
106. MARYLEBONE	23,888	—	—	23,888	Estimated at 300	—	**23,588**	5,103	—	—	5,103	—	**5,103**
107. MIDHURST	362	—	—	362	53	—	**309**	50	—	—	50	—	**50**
108. MONMOUTH	2,125	21	—	2,146	48	11	**2,087**	825	10	—	835	1	**834**
109. MORPETH	389	96	—	485	12	25	**448**	73	79	—	152	10	**142**
110. NEWARK	540	—	171	711	—	1	**710**	164	—	115	279	—	**279**
111. NEWCASTLE-UNDER-LYME	463	718	—	1,181	—	104	**1,077**	36	575	—	611	22	**589**
112. NEWCASTLE-UPON-TYNE	5,618	1,842	—	7,460	421	409	**6,630**	920	742	—	1,662	103	**1,559**
113. NEWPORT (ISLE OF WIGHT)	662	2	—	664	19	2	**643**	219	—	—	219	—	**219**

* The Returning Officer states that neither the Corporation nor the Overseers have any means of making a Return of the Double Entries. This information has been supplied to him by the "Liberal Registration Society."

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
114. NORTHALLERTON -	452	—	2	454	11	1	442	137	—	—	137	—	137
115. NORTHAMPTON - -	2,579	—	278	2,857	68	169	2,620	1,151	—	160	1,311	62	1,249
116. NORWICH - -	2,439	1,971	1,272	5,682	109	756	4,817	326	1,063	266	1,655	65	1,590
117. NOTTINGHAM - -	4,329	1,565	1,027	6,921	59	928	5,934	1,107	1,198	370	2,675	333	2,342
118. OLDHAM - - -	2,316	—	—	2,316	31	—	2,285	315	—	—	315	—	315
119. OXFORD - -	2,162	951	—	3,113	—	519	2,594	750	502	—	1,252	—	1,252
120. PENRYN AND FALMOUTH	816	—	71	887	28	22	837	250	—	49	299	9	290
121. PETERBOROUGH - -	609	—	44	653	1	11	641	111	—	33	144	1	143
122. PETERSFIELD - -	323	—	—	323	27	—	296	37	—	—	37	—	37
123. PLYMOUTH - -	3,109	14	—	3,123	173	6	2,944	497	1	—	498	3	495
124. POOLE - -	556	12	—	568	39	8	521	17	—	—	17	—	17
125. PONTEFRACT - -	652	—	80	732	28	5	699	98	—	66	164	2	162
126. PORTSMOUTH - -	4,670	1	—	4,671	—	1	4,670	1,266	—	—	1,266	—	1,266
127. PRESTON - -	2,224	—	425	2,649	—	87	2,562	327	—	299	626	86	540

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
128. Reading - -	1,830	—	2	1,832	61	2	1,769	522	—	—	522	—	522
129. Reigate - - -	926	—	—	926	6	—	920	394	—	—	394	—	394
130. Retford, East -	2,398	64	75	2,537	27	21	2,489	240	29	10	279	1	278
131. Richmond - -	312	—	6	318	—	2	316	64	—	—	64	—	64
132. Ripon - -	349	—	—	349	1	—	348	38	—	—	38	—	38
133. Rochdale - -	1,442	—	—	1,442	84	—	1,358	68	—	—	68	—	68
134. Rochester - -	1,225	374	—	1,599	22	119	1,458	423	145	—	568	29	539
135. Rye - - -	388	4	—	392	18	1	373	53	—	—	53	—	53
136. Salford - -	5,458	—	—	5,458	61	—	5,397	1,806	—	—	1,806	—	1,806
137. Salisbury - -	702	—	2	704	12	1	691	73	—	—	73	—	73
138. Sandwich - -	841	228	—	1,069	—	15	1,054	77	78	—	155	13	142
139. Scarborough - -	1,437	9	—	1,446	89	6	1,351	556	—	—	556	—	556
140. Shaftesbury - -	476	—	30	506	30	15	461	91	—	18	109	7	102
141. Sheffield - -	9,136	—	—	9,136	579	—	8,557	2,224	—	—	2,224	—	2,224
142. Shoreham, New -	1,906	—	93	1,999	—	21	1,978	456	—	9	465	3	462

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
143. Shrewsbury - -	1,371	406	—	1,777	50	174	1,553	327	207	—	534	37	497
144. Southampton - -	4,147	4	79	4,230	30	11	4,189	2,086	—	5	2,091	7	2,084
145. South Shields -	1,211	—	—	1,211	98	—	1,113	260	—	—	260	—	260
146. Southwark - -	11,575	—	71	11,646	—	15	11,631	5,515	—	—	5,515	—	5,515
147. Stafford - -	666	973	—	1,639	9	90	1,540	85	834	—	919	31	888
148. Stamford - -	484	—	43	527	13	2	512	87	—	38	125	—	125
149. Stoke-upon-Trent -	3,204	—	—	3,204	15	—	3,189	859	—	—	859	1	858
150. Stockport - -	1,391	—	—	1,391	43	—	1,348	124	—	—	124	—	124
151. Stroud - -	1,400	—	—	1,400	44	—	1,356	203	—	—	203	—	203
152. Sunderland - -	3,468	—	—	3,468	—	—	3,468	606	—	—	606	—	606
153. Tamworth - -	529	—	31	560	25	3	532	186	—	14	200	—	200
154. Taunton - -	843	—	54	897	31	27	839	208	—	30	238	4	234
155. Tavistock - -	424	—	3	427	—	1	426	121	—	—	121	—	121
156. Tewkesbury - -	312	21	9	342	—	17	325	79	6	—	85	1	84
157. Thetford - -	232	—	5	237	8	5	224	41	—	—	41	—	41

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
158. Thirsk - - -	383	—	—	383	3	—	380	89	—	—	89	—	89
159. Tiverton - -	461	4	—	465	—	—	465	34	—	—	34	—	34
160. Totnes - - -	389	6	—	395	10	3	382	35	—	—	35	—	35
161. Tower Hamlets -	34,115	—	—	34,115	—	—	34,115	8,107	—	—	8,107	—	8,107
162. Truro - - -	639	1	—	640	72	1	567	48	—	—	48	—	48
163. Tynemouth - -	1,271	—	—	1,271	—	—	1,271	134	—	—	134	—	134
164. Wakefield - -	1,188	—	—	1,188	102	—	1,086	122	—	—	122	—	122
165. Wallingford - -	374	—	5	379	19	3	357	47	—	—	47	2	45
166. Walsall - -	1,296	—	—	1,296	—	—	1,296	217	—	—	217	—	217
167. Wareham - -	285	—	13	298	14	11	273	56	—	—	56	—	56
168. Warrington - -	779	—	—	779	11	—	768	149	—	—	149	—	149
169. Warwick - -	641	—	125	766	2	74	690	122	42	—	164	—	164
170. Wells - -	230	66	—	296	3	19	274	4	39	—	43	1	42
171. Wenlock - -	851	142	—	993	9	23	961	184	84	—	268	7	261
172. Westbury - -	300	—	—	300	—	—	300	142	—	—	142	—	142

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2. Total Electors on Register.	3. Double Entries.		4. Actual Number of Persons entitled to vote.	5. The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6. The Number of Electors in Column 5, who are on the Register in respect of more than One Qualification.	7. Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.		As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.		£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.		
173. Westminster - -	12,386	—	431	12,817	—	271	**12,546**	1,514	—	2	1,516	23	**1,493**
174. Weymouth and Melcombe Regis - -	931	4	3	938	25	7	**906**	356	—	—	356	—	**356**
175. Whitby - - -	761	—	—	761	58	—	**703**	30	—	—	30	—	**30**
176. Whitehaven - -	648	—	—	648	—	—	**648**	138	—	—	138	—	**138**
177. Wigan - - - -	862	—	3	865	—	2	**863**	205	—	—	205	—	**205**
178. Wilton - -	273	—	—	273	8	—	**265**	35	—	—	35	—	**35**
179. Winchester - -	988	3	—	991	25	3	**963**	228	—	—	228	—	**228**
180. Windsor - -	657	—	—	657	6	—	**651**	215	—	—	215	—	**215**
181. Wolverhampton -	4,891	—	—	4,891	61	—	**4,830**	1,244	—	—	1,244	—	**1,244**
182. Woodstock - -	280	16	—	296	3	7	**286**	22	4	—	26	—	**26**
183. Worcester - -	1,944	732	—	2,676	106	261	**2,309**	587	346	—	933	72	**861**
184. Wycombe - -	551	2	—	553	1	1	**551**	116	—	—	116	—	**116**
185. Yarmouth - -	1,650	—	—	1,650	5	—	**1,645**	327	—	—	327	3	**324**
186. York - - -	2,153	2,571	—	4,724	101	346	**4,277**	112	1,381	—	1,493	23	**1,470**
Total of Metropolitan Boroughs -	147,229	5,514	502	153,245	770	1,846	**150,629**	35,062	238	2	35,302	23	**35,279**
Total of **ENGLAND** (exclusive of Metropolitan Boroughs)	303,767	34,701	7,955	346,423	11,030	11,013	**324,380**	70,308	19,043	2,182	91,533	1,911	**89,622**
Total of **ENGLAND**	450,996	40,215	8,457	499,668	11,800	12,859	**475,009**	105,370	19,281	2,184	126,835	1,934	**124,901**

Borough or City.	1. Number of Electors on Register, 1865–6, classed according to Qualifications.			2.	3. Double Entries.		4.	5 The Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.				6.	7.
	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total Electors on Register.	As £10 Occupiers.	As £10 Occupiers and Freemen, or Scot and Lot Voters, Potwallers, or other Ancient-right Qualifications.	Actual Number of Persons entitled to vote.	£10 Occupiers.	Freemen.	Scot and Lot Voters, Potwallers, and other Ancient-right Qualifications.	Total.	The Number of Electors in Column 5. who are on the Register in respect of more than One Qualification.	Actual Number of Electors who come within the Description of Mechanics, Artizans, and other Persons supporting themselves by daily manual Labour.
WALES.													
187. Beaumaris	561	2	—	563	4	1	558	180	—	—	180	—	180
188. Brecon	293	—	—	293	12	—	281	82	—	—	82	—	82
189. Cardiff	1,889	234	—	2,123	10	41	2,072	662	122	—	784	9	775
190. Cardigan	637	55	—	692	1	6	685	83	5	—	88	1	87
191. Carmarthen	775	41	—	816	—	25	791*	152	—	—	152	—	152
192. Carnarvon	1,027	—	66	1,093	—	23	1,070	177	—	31	208	—	208
193. Denbigh	805	129	—	934	—	31	903	86	76	—	162	7	155
194. Flint	601	—	99	700	—	11	689	161	—	51	212	6	206
195. Haverfordwest	406	191	215	812	2	141	669	116	113	82	311	66	245
196. Merthyr Tydfil	1,387	—	—	1,387	—	—	1,387	126	—	—	126	—	126
197. Montgomery	954	61	—	1,015	19	31	965	171	40	—	211	14	197
198. Pembroke	1,102	377	—	1,479	1	45	1,433	515	284	—	799	23	776
199. Radnor	420	24	—	444	—	3	441	51	1	—	52	—	52
200. Swansea	1,695	312	—	2,007	—	40	1,967	366	96	—	462	1	461
Total for **WALES**	12,552	1,426	380	14,358	49	398	13,911	2,928	737	164	3,829	127	3,702
Total for **ENGLAND** and **WALES**	463,548	41,641	8,837	514,026	11,849	13,257	488,920	108,298	20,018	2,348	130,664	2,061	128,603

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* These numbers are taken from the Register 1864–65, the Register for the present year not having been printed when the Return was applied for.

Return C.

BOROUGHS: ELECTORAL RETURNS, Parliamentary and Municipal.

Return of the Number of Electors on the Parliamentary Register for each City and Borough in England and Wales for 1865–6; and also the total Number of Burgesses on the Burgess Lists for 1865–6; the Number of such Burgesses whose Rates are assessed on the Owner, or compounded for by him; and the Number who are on the Parliamentary Register; at the same time stating whether the Parliamentary and Municipal Boundaries are conterminous or not.

Name of City or Borough.	1. Total Number of Electors on Parliamentary Register, 1865–6. *	2. Total Number of Electors on Burgess Lists, 1865–6.	3. Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him.	4. Number of Burgesses who are on Parliamentary Register.	5. Whether the Parliamentary and Municipal Boundaries are conterminous. "Yes" or "No."
ENGLAND.					
1. Abingdon - - - -	329	383	91	309	Yes.
2. Andover - - - -	263	243	1	233	No.
3. Arundel - - - -	174	337	None.	157	Yes.
4. Ashburton - - - -	356	—	—	—	—
5. Ashton-under-Lyne - -	967	2,574	1,816	764	No, but nearly so.
6. Aylesbury - - - -	1,329	—	—	—	—
7. Banbury - - - -	763	425	111	310	No.
8. Barnstaple - - - -	763	1,158	377	511	Yes.
9. Bath - - - -	3,236	3,488	25	2,498	Yes.
10. Bedford - - - -	1,108	1,703	410	918	Yes.
11. Berwick-upon-Tweed -	816	825	198	582	Yes.
12. Beverley - - - -	1,474	1,229	None.	691	No.
13. Bewdley - - - -	361	166	None.	120	No.
14. Birkenhead - - - -	4,563	—	—	—	—
15. Birmingham - - - -	15,497	17,840	6,446	11,984	Yes.
16. Blackburn - - - -	1,894	6,486	4,403	1,580	Yes.
17. Bodmin - - - -	403	490	None.	219	No.
18. Bolton - - - -	2,293	8,092	4,769	1,924	Yes.
19. Boston - - - -	1,093	1,720	1,194	719	No.

* The number of Parliamentary Electors and of Burgesses *includes* double entries.

NAME OF CITY OR BOROUGH.	1. Total Number of Electors on Parliamentary Register, 1865-6.	2. Total Number of Electors on Burgess Lists, 1865-6.	3. Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him.	4. Number of Burgesses who are on Parliamentary Register.	5. Whether the Parliamentary and Municipal Boundaries are conterminous. "Yes" or "No."
20. BRADFORD - - -	5,189	19,604	10,844	5,189	Yes.
21. BRIDGNORTH - - -	658	621	268	273	No.
22. BRIDGWATER - - -	679	*619	None.	546	Yes.
23. BRIDPORT - - -	503	716	837	380	Yes.
24. BRIGHTON - - -	6,352	3,739	None.	3,478	No.
25. BRISTOL - - -	14,324	11,631	2,568	8,507	Yes.
26. BUCKINGHAM - - -	407	492	302	178	No.
27. BURY - - - - -	1,366	—	—	—	—
28. BURY ST. EDMUNDS - -	697	1,504	788	615	Yes.
29. CALNE - - - -	175	214	106	99	No.
30. CAMBRIDGE - - -	1,926	2,615	588	1,580	Yes.
31. CANTERBURY - - -	1,808	1,576	467	1,060	Yes.
32. CARLISLE - - -	1,506	3,377	2,450	1,035	Yes.
33. CHATHAM - - -	2,111	—	—	—	—
34. CHELTENHAM - - -	2,793	—	—	—	—
35. CHESTER - - -	2,700	3,893	2,312	1,423	Yes.
36. CHICHESTER - - -	587	748	198	390	Yes.
37. CHIPPENHAM - - -	407	158	15	132	No.
38. CHRISTCHURCH - -	419	—	—	—	—
39. CIRENCESTER - - -	464	—	—	—	—
40. CLITHEROE - - -	484	791	None.	211	No.
41. COCKERMOUTH - - -	356	—	—	—	—
42. COLCHESTER - - -	1,424	2,661	1,485	1,131	Yes.
43. COVENTRY - - -	4,967	4,236	1,893	2,472	No. †
44. CRICKLADE - - -	2,094	—	—	—	—
45. DARTMOUTH - - -	295	339	None.	224	Yes.
46. DERBY - - -	2,532	6,001	2,304	2,223	Yes.
47. DEVIZES - - -	369	421	103	288	Yes.
48. DEVONPORT - - -	2,860	2,210	None.	1,823	No.

* Until this year the occupiers of houses compounded for have been on the list, and last year the total number on the list was 1768. This year the Overseers List delivered comprised only the persons actually rated, and as there were no claims made the list remained as returned, hence the reduced number.

† But the difference affects only a very small portion of the Voters.

Name of City or Borough.	1. Total Number of Electors on Parliamentary Register, 1865–6.	2. Total Number of Electors on Burgess Lists, 1865–6.	3. Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him.	4. Number of Burgesses who are on Parliamentary Register.	5. Whether the Parliamentary and Municipal Boundaries are conterminous. "Yes" or "No."
49. DORCHESTER - - -	451	586	112	386	Yes.
50. DOVER - - -	2,414	2,021	213	1,549	Yes.
51. DROITWICH - - -	400	508	287	143	No.
52. DUDLEY - - -	1,358	6,363	4,339	1,307	Yes.
53. DURHAM - - - -	1,149	1,245	133	718	Yes.
54. EVESHAM - - -	372	617	316	288	Yes.
55. EXETER - - -	3,689	3,396	7	1,855	No.
56. EYE - - - -	346	236	122	110	No.
57. FINSBURY - - -	25,491	—	—	—	—
58. FROME - - - -	414	—	—	—	—
59. GATESHEAD - - -	1,172	2,619	1,433	1,094	Yes.
60. GLOUCESTER - - -	1,846	1,629	398	1,023	Yes.
61. GRANTHAM - - -	886	427	159	263	No.
62. GREENWICH - - -	9,813	—	—	—	—
63. GRIMSBY, GREAT - -	1,358	1,454	None	714	No.
64. GUILDFORD - - -	725	600	42	511	Yes.
65. HALIFAX - - - -	1,788	6,100	3,000 out of 8,500.	1,628	No.*
66. HARWICH - - -	389	466	None	326	Yes.
67. HASTINGS - - -	1,941	1,840	50	1,499	Yes.
68. HELSTON - - -	363	203	None	138	No.
69. HEREFORD - - -	1,314	1,812	552	943	Yes.
70. HERTFORD - - -	602	636	148	432	Yes.
71. HONITON - - -	288	343	146	227	Yes.
72. HORSHAM - - -	400	—	—	—	—
73. HUDDERSFIELD - - -	2,138	—	—	—	—
74. HUNTINGDON - - -	408	473	225	211	No.
75. HYTHE - - - -	1,313	326	160	166	No.

* The Burgess Return, however, is confined to that part of the Borough within the Parliamentary Boundary.

NAME OF CITY OR BOROUGH.	1. Total Number of Electors on Parliamentary Register, 1865-6.	2. Total Number of Electors on Burgess Lists, 1865-6.	3. Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him.	4. Number of Burgesses who are on Parliamentary Register.	5. Whether the Parliamentary and Municipal Boundaries are conterminous. "Yes" or "No."
76. IPSWICH - - -	2,237	4,297	2,130	1,487	Yes.
77. IVES, ST. - - - -	536	1,072	None	321	No.
78. KENDAL - - - -	454	1,579	1,049	427	Yes.
79. KIDDERMINSTER - -	625	1,497	923	574	Yes.
80. KING'S LYNN - - -	901	1,142	None	713	Yes.
81. KINGSTON-UPON-HULL - -	6,498	7,505	1,769	4,547	Yes.
82. KNARESBOROUGH - -	290	—	—	—	—
83. LAMBETH - - -	27,754	—	—	—	—
84. LANCASTER - - -	1,473	1,122	530	519	No.
85. LAUNCESTON - - -	421	290	None	154	No.
86. LEEDS - - - -	8,485	32,877	18,465	6,066	Yes.
87. LEICESTER - - -	5,438	4,986	2,120	2,957	Yes.
88. LEOMINSTER - - -	408	563	232	363	Yes.
89. LEWES - - - -	720	—	—	—	—
90. LICHFIELD - - -	720	893	455	438	Yes.
91. LINCOLN - - -	1,813	2,865	1,816	1,152	Yes.
92. LISKEARD - - -	450	538	8	429	No.
93. LIVERPOOL* - - -	21,839	15,102	614	13,396	Yes.
94. LONDON, CITY OF - -	17,534	—	—	—	—
95. LUDLOW - - - -	426	335	31	298	No.
96. LYME REGIS - - -	252	232	40	164	No.
97. LYMINGTON - - -	349	265	87	171	No.
98. MACCLESFIELD - - -	964	6,061	5,194	867	Yes.
99. MAIDSTONE - - -	1,973	2,036	1,201	1,328	No, but nearly so.†
100. MALDON - - -	904	700	352	300	No.
101. MALMESBURY - - -	370	—	—	—	—
102. MALTON - - -	603	—	—	—	—
103. MANCHESTER - - -	22,792	17,995	3,656	13,685	No.

* In this case the net number only of the Electors and Burgesses is given.

† A small district of land within the Parliamentary limit is out of the Municipal Boundary.

Name of City or Borough.	1. Total Number of Electors on Parliamentary Register, 1865–6.	2. Total Number of Electors on Burgess Lists, 1865–6.	3. Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him.	4. Number of Burgesses who are on Parliamentary Register.	5. Whether the Parliamentary and Municipal Boundaries are conterminous. "Yes" or "No."
104. MARLBOROUGH - -	304	400	183	213	No.
105. MARLOW, GREAT - -	354	—	—	—	—
106. MARYLEBONE - - -	23,888	—	—	—	—
107. MIDHURST - - -	362	—	—	—	—
108. MONMOUTH - - -	2,146	424	120	267	No.
109. MORPETH - - -	485	474	274	181	No.
110. NEWARK - - -	711	1,534	None	662	Yes.
111. NEWCASTLE-UNDER-LYME -	1,181	1,001	None	582	Yes.
112. NEWCASTLE-UPON-TYNE -	7,460	9,924	3,551	6,788	Yes.
113. NEWPORT (ISLE OF WIGHT) -	664	736	71	565	Yes.
114. NORTHALLERTON - -	454	—	—	—	—
115. NORTHAMPTON - -	2,857	3,867	1,315	2,113	Yes.
116. NORWICH - - -	5,682	3,383	58	2,666	Yes.
117. NOTTINGHAM - - -	6,921	6,910	2,331	4,031	Yes.
118. OLDHAM - - - -	2,316	5,067	None	1,418	No.
119. OXFORD - - -	3,113	2,939	None	2,219	Yes.
120. PENRYN AND FALMOUTH -	887	632	None	328	No.
121. PETERBOROUGH - -	653	—	—	—	—
122. PETERSFIELD - - -	323	—	—	—	—
123. PLYMOUTH - - -	3,123	2,816	15	2,548	No.*
124. POOLE - - - -	568	701	124	552	Yes.
125. PONTEFRACT - - -	732	691	330	319	No.†
126. PORTSMOUTH - - -	4,671	9,419	4,698	3,089	Yes.
127. PRESTON - - -	2,649	7,991	5,797	1,974	Yes.
128. READING - - -	1,832	1,468	None	1,337	Yes.
129. REIGATE - - - -	926	966	141	746	Yes.
130. RETFORD, EAST - -	2,537	391	173	189	No.

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* But all the Parliamentary Electors and Burgesses reside within the same limits.

† The Municipal Borough and Township of Pontefract are conterminous. The number of voters on the Parliamentary Reg in respect of qualifications within the Township of Pontefract is 394.

Name of City or Borough.	1. Total Number of Electors on Parliamentary Register, 1865–6.	2. Total Number of Electors on Burgess Lists, 1865–6.	3. Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him.	4. Number of Burgesses who are on Parliamentary Register.	5. Whether the Parliamentary and Municipal Boundaries are conterminous "Yes" or "No."
131. Richmond	318	455	None	217	Yes.
132. Ripon	349	775	309	316	Yes.
133. Rochdale	1,442	5,356	None	1,345	Yes.*
134. Rochester	1,599	1,454	318	1,048	Yes.
135. Rye	392	445	178	194	Yes.
136. Salford	5,458	8,751	6,028	3,477	Yes.
137. Salisbury	704	691	44	593	Yes.
138. Sandwich	1,069	381	—	224	No.
139. Scarborough	1,446	2,361	2,056	1,222	Yes.
140. Shaftesbury	506	309	None	140	No.
141. Sheffield	9,136	23,091	None	7,937	Yes.
142. Shoreham, New	1,999	—	—	—	—
143. Shrewsbury	1,777	2,495	933	1,267	Yes.
144. Southampton	4,230	3,904	751	2,869	Yes.
145. South Shields	1,211	2,300	1,129	1,170	Yes.
146. Southwark	11,646	—	—	—	—
147. Stafford	1,639	1,411	35	794	Yes.
148. Stamford	527	940	None	470	Yes.
149. Stoke-upon-Trent	3,204	—	—	—	—
150. Stockport	1,391	2,798	None	963	Yes.
151. Stroud	1,400	—	—	—	—
152. Sunderland	3,468	4,339	79	2,780	No.
153. Tamworth	560	541	353	235	No.
154. Taunton	897	—	—	—	—
155. Tavistock	427	—	—	—	—
156. Tewkesbury	342	656	340	279	Yes.
157. Thetford	237	673	None	221	Yes.
158. Thirsk	383	—	—	—	—

* For all practical purposes "Yes." The Districts comprising the Municipal and Parliamentary limits are circles having the same diameter (one and a half miles), but the centres of such circles are about 15 yards from each other.

NAME OF CITY OR BOROUGH.	1. Total Number of Electors on Parliamentary Register, 1865–6.	2. Total Number of Electors on Burgess Lists, 1865–6.	3. Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him.	4. Number of Burgesses who are on Parliamentary Register.	5. Whether the Parliamentary and Municipal Boundaries are conterminous. "Yes" or "No."
159. TIVERTON - - -	465	913	434	417	Yes.
160. TOTNES - - -	395	479	None	280	Yes.
161. TOWER HAMLETS - -	34,115	—	—	—	—
162. TRURO - - -	640	1,324	721	488	Yes.
163. TYNEMOUTH - -	1,271	2,073	233	1,102	Yes.
164. WAKEFIELD - -	1,188	2,165	351	822 exclusive of Duplicates.	Nearly so.
165. WALLINGFORD - -	379	304	118	150	No.
166. WALSALL - - -	1,296	1,470	185	1,092	Yes.
167. WAREHAM - - -	298	—	—	—	—
168. WARRINGTON - -	779	1,443	200	566	No.*
169. WARWICK - - -	766	1,416	719	603	Yes.
170. WELLS - - -	296	424	None.	213	Yes.
171. WENLOCK - - -	993	2,386	Not ascertained.	724	No.
172. WESTBURY - - -	300	—	—	—	—
173. WESTMINSTER - -	12,817	—	—	—	—
174. WEYMOUTH - -	938	1,157	323	780	Yes.
175. WHITBY - - -	761	—	—	—	—
176. WHITEHAVEN - -	648	—	—	—	—
177. WIGAN - - -	865	2,931	2,069	862	Yes.
178. WILTON - - -	273	—	—	—	—
179. WINCHESTER - -	991	1,233	290	963	Yes.
180. WINDSOR - - -	657	731	223	524	Yes.
181. WOLVERHAMPTON - -	4,891	3,064	97	2,311	No.
182. WOODSTOCK - -	296	—	—	—	—
183. WORCESTER - -	2,676	3,052	867	1,546	Yes.
184. WYCOMBE - - -	553	480	161	251	No.†
185. YARMOUTH - -	1,650	2,408	388‡	1,357	Yes.
186. YORK - - -	4,724	4,923	1,228	2,571	No.
TOTAL FOR **ENGLAND** -	499,668	413,413	140,224	200,833	

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* The Overseers of the Township of Warrington, acting under the advice of their Attorney, have this year [illegible] omitted from the Burgess List all occupiers whose rates were compounded for, and not one of them sent in a [illegible] name inserted. In the Burgess Roll for 1864–65 there were 1,710 occupiers whose rates were compounded for.

† Population of the Municipal Borough in 1861, 4,222; of the Parliamentary Borough, 8,375.

‡ The Small Tenements *Act* has *just* been adopted: next year the number in this column will [illegible]

Name of City or Borough.	1. Total Number of Electors on Parliamentary Register, 1865–6.	2. Total Number of Electors on Burgess Lists, 1865–6.	3. Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him.	4. Number of Burgesses who are on Parliamentary Register.	5. Whether the Parliamentary and Municipal Boundaries are conterminous. "Yes" or "No."
WALES.*					
187. Beaumaris - - -	563	286	185	93	No.
188. Brecon - - -	293	681	394	247	No.
189. Cardiff - - -	2,123	1,643	448	1,303	No.
190. Cardigan - - -	692	285	106	151	No.
191. Carmarthen - -	816	513	None.	483	No.
192. Carnarvon - - -	1,093	1,086	732	300	No.
193. Denbigh - - -	934	974	744	264	No.
194. Flint - - - -	700	305	23	107	No.
195. Haverfordwest - -	812	835	402	354	No.
196. Merthyr Tydfil - -	1,387	—	—	—	—
197. Montgomery - -	1,015	—	—	—	—
198. Pembroke - - -	1,479	1,564	212	597	No.
199. Radnor - - -	444	—	—	—	—
200. Swansea - - -	2,007	3,422	495	1,428	No.
Total for **WALES** -	14,358	11,594	3,741	5,327	
Total for **ENGLAND** and **WALES** - -	514,026	425,007	143,965	206,160	
Total for Boroughs, the Parliamentary and Municipal Boundaries of which are conterminous - - - As in Abstracts 1, 2, and 3.	224,176	346,537	129,447	163,138	

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* The several Welsh Boroughs, with the exception of Brecon and Merthyr Tydfil, have one or more contributory Boroughs annexed to them for Parliamentary purposes. In these cases the number of Parliamentary Electors is inclusive of those on the Register for the contributory Boroughs also. The number of Burgesses is restricted to those on the Burgess Lists for the Boroughs actually named.

Return D.

SMALL TENEMENTS AND LOCAL RATING ACTS.

No. 1.

List of Parliamentary Boroughs in which the Small Tenements Rating Act (13 & 14 Vict. c. 99. (a)) is in force throughout all the Parishes comprised therein.

ENGLAND.

Abingdon.
Ashton-under-Lyne.
Banbury.
Berwick-upon-Tweed.
Blackburn.
Bury St. Edmunds.
Calne.
Carlisle.*
Chatham.
Chippenham.
Christchurch.
Cirencester.
Coventry.
Derby.
Devizes.
Dudley.†
Evesham.
Gateshead.
Harwich.
Honiton.
Horsham.
Huntingdon.
Lancaster.
Leeds.
Leominster.
Lymington.
Macclesfield.
Maldon.
Malmsbury.
Marlborough.
Monmouth.
Newcastle-upon-Tyne.
Northampton.
Petersfield.
Poole.
Portsmouth.
Preston.
Reading.
Reigate.
Ripon.
Shrewsbury.
South Shields.
Sunderland.
Tavistock.
Tewkesbury.
Tiverton.
Truro.
Warwick.
Westbury.
Weymouth.
Whitehaven.
Wigan.
Windsor.
Worcester.‡
Wycombe.

WALES.

Brecknock.
Denbigh.
Merthyr Tydfil.

In all 58 Boroughs.

* Not in force in "Eaglesfield Abbey," but in that parish there are, according to the last Census, only 40 inhabitants.

† Not in force in "Dudley Castle Hill." This place only contains 24 inhabitants according to the last Census.

‡ Not in force in the "College Precincts."

No. 2.

List of Parliamentary Boroughs in which the Small Tenements Rating Act (13 & 14 Vict. c. 99.) is in force, but not throughout *all* the Parishes comprised therein.

ENGLAND.

Andover.
Aylesbury.
Barnstaple
Bath.
Bedford.
Birkenhead.
Bolton.
Boston.
Bradford.
Bridgnorth.
Bridgwater.
Bridport.
Bristol.
Buckingham.
Cambridge.
Canterbury.
Chester.
Chichester.
Cockermouth.
Colchester.
Cricklade.
Dorchester.
Dover.
Droitwich.
Durham.
Eye.
Finsbury.
Frome.
Gloucester.
Grantham.
Greenwich.
Great Grimsby.
Guildford.
Halifax.
Hastings.
Helston.
Hereford.
Hertford.
Hythe.
Ipswich.
Kendal.
Kingston-upon-Hull.
Launceston.
Leicester.
Lewes.
Lichfield.

(a) By sect. 1 of this Act the vestry of any parish is empowered to declare and order that the O[illegible] tenements the yearly rateable value whereof shall not exceed £6 shall be rated instead of the Occup[illegible].

Lincoln.
Liskeard.
Liverpool.
London, City.
Ludlow.
Lyme Regis.
Manchester.
Marlow, Great.
Midhurst.
Morpeth.
Newark.
Newport (Isle of Wight).
Northallerton.
Nottingham.
Penryn and Falmouth.
Peterborough.
Pontefract.
East Retford.
Rochester.
Rye.
Salford.
Salisbury.
Sandwich.
Scarborough.
Shaftesbury.
Shoreham, New.
Southampton.
Stafford.
Stroud.
Tamworth.
Taunton.
Tynemouth.
Wakefield.
Wallingford.
Wareham.
Warrington.
Wenlock.
Wilton.
Winchester.
Wolverhampton.
Woodstock.

WALES.

Beaumaris.
Cardiff.
Cardigan.
Carmarthen.
Carnarvon.
Flint.
Haverfordwest.
Montgomery.
Pembroke.
Radnor.
Swansea.

In all **98** Boroughs.

No. 3.

Boroughs in which the Small Tenements Rating Act (13 & 14 Vict. c. 99.) has not been adopted.

Arundel.
Ashburton.
Beverley.
Bewdley.
Birmingham.
Bodmin.
Brighton.
Bury.
Cheltenham.
Clitheroe.
Dartmouth.
Devonport.
Exeter.
Huddersfield.
St. Ives.
Kidderminster.
Kings Lynn.
Knaresborough.
Lambeth.
Maidstone.
Malton.
Marylebone.
Newcastle-under-Lyme.
Norwich.
Oldham.
Oxford.
Plymouth.
Richmond.
Rochdale.
Sheffield.
Southwark.
Stamford.
Stockport.
Stoke-upon-Trent.
Thetford.
Thirsk.
Totnes.
Tower Hamlets.
Walsall.
Wells.
Westminster.
Whitby.
Yarmouth.
York.

In all **44** Boroughs.

The Names of those Boroughs in which Local Acts appear to be in force (see No. 6.) are printed in *Italics.*

SUMMARY.

Boroughs wholly under 13 & 14 Vict. c. 99. - - -	58
„ partly - - - - - - -	98
„ not - - - - -	44
	200

No. 4.

LIST of Boroughs in which the Small Tenements Rating Act (13 & 14 Vict. c. 99.) and a Local Act or Local Acts for rating the Owners instead of the Occupiers appear to be in force.

(In Boroughs marked * the 59 Geo. 3. c. 12. s. 19. (*a*) has been adopted. [Parliamentary Paper No. 33, 1862].)

Aylesbury.
Bristol.
Canterbury.
Chatham.
*Finsbury.
Greenwich.
Kingston-upon-Hull.
Leicester.
*London, City.
*Manchester.
*Rochester.
Salisbury.
Southampton.
Wolverhampton.

In all **14** Boroughs.

No. 5.

LIST of Boroughs in which the Provisions of the 59 Geo. 3. c. 12. s. 19. appear to have been wholly or partly adopted.

Bath.
Dover. The Act is given as the 59 Geo. 3., no Cap. being stated.
Exeter.
Finsbury.
London, City.
Maidstone.
Manchester.
Preston. (See as to Dover.)
Radnor.
Reading.
Rochester.
Salford.
Tower Hamlets.

In all **13** Boroughs.

(*a*) By sec. 19 of the 59 Geo. 3. c. 12. the vestry of any parish is empowered to resolve and direct that the Owners of all houses, apartments, or dwellings which are let at any rent or rate not exceeding £20 nor less than £6 by the year for any less term than one year, *or* on any agreement by which the rent shall be reserved at any shorter period than three months, shall be rated instead of the Occupiers.

No. 6.

LIST of Boroughs in which Local Acts providing for the rating of Owners instead of Occupiers are in force.

Name of Borough.	Title of Act.	Parishes in which the Act is in force.	Limit of Rental or Value to which the Act applies.	
			£	s.
Aylesbury	9 Vict. c. 3.	Aylesbury with Walton	Under 10	0
Bewdley	12 Vict. c. 12.	Bewdley, Kidderminster Foreign, Lower Mitton, and Ribbesford.	7	0
Birmingham	9 & 10 Vict. c. 225.	Aston	7	0
	1 & 2 Will. 4. c. 67.	Birmingham	12	0
	10 & 11 Vict. c. 66.	Edgbaston	7	10
Brighton	6 Geo. 4. c. 179.	Brighton	20	0
Bristol	3 Geo. 4. c. 24.	City of Bristol	Under 20	0
	2 Will. 4. c. 89.	St. James and St. Paul (County of Gloucester).	Under 12	0
Canterbury	54 Geo. 3. c. 114.	City of Canterbury	10	0
Chatham	42 Geo. 3. c. 56.	Chatham.	—	
Finsbury	15 Geo. 3. c. 23.	Clerkenwell	Under 10	0
	20 & 21 Vict. c. 118.	Islington	20	0
	50 Geo. 3. c. 84.	Rolls Liberty	15	0
	6 Geo. 4. c. 175.	St. Andrew, Holborn	20	0
	11 Geo. 4. c. 10.	St. George, Bloomsbury; St. Giles-in-the-Fields.	Under 30	0
	6 Geo. 4. c. 175.	St. George-the-Martyr	20	0
	48 Geo. 3. c. 97.	St. Luke	15	0
	12 Geo. 3. c. 68.	St. Sepulchre	Under 10	0
Greenwich	9 Geo. 4. c. 4.	East Greenwich (?)	15	0
	27 Geo. 2. c.	St. Nicholas, Deptford.	—	
		St. Paul, Deptford.	—	
	47 Geo. 3. Sess. 2. c. 111.	Woolwich	12	0
Kidderminster	4 & 5 Vict. c. 72.	Kidderminster Borough	Under 10	0
	12 Vict. c. 12.	Kidderminster Foreign	7	0
Kings Lynn	5 Geo. 4. c. 41.	All Saints, South Lynn	8	0
	48 Geo. 3. c. 22.	Kings Lynn, St. Margaret	8	0
Kingston-upon-Hull	5 Geo. 4. c. 13.	Holy Trinity and St. Mary	Under 10	0
	4 Will. 4. c. 5.	Sculcoates	Under 10	0
Lambeth	3 Will. 4. c. 33.	Camberwell	20	0
	50 Geo. 3. c. 19.	Lambeth	Under 20	0
	54 Geo. 3. c. 113.	Newington	20	0
Leicester	2 Will. 4. c. 10.	St. Margaret.	—	
London, City	51 Geo. 3. c. 153.	St. Botolph-without-Aldgate	20	0
	35 Geo. 3. c. 61.	St. Botolph-without-Bishopsgate	Under 10	0
	7 Geo. 4. c. 114.	St. Bride	30	0

Name of Borough.	Title of Act.	Parishes in which the Act is in force.	Limit of Rental or Value to which the Act applies.
			£ s.
Maidstone	45 Geo. 3. c. 118.	Maidstone	12 0
Manchester	21 & 22 Vict. c. 62.	Ardwick	10 0
		Chorlton-upon-Medlock	
		Hulme	
		Manchester	
Marylebone	5 Geo. 4. c. 126.	Paddington	20 0
	3 Geo. 4. c. 84.	Marylebone	Not above 20 0 and not less than 6 0
	59 Geo. 3. c. 39.	St. Pancras	20 0
Norwich	26 & 27 Vict. c. 93.	Norwich City	9 0
Oxford	17 & 18 Vict. c. 219.	—	—
Plymouth	53 Geo. 3. c. 73.	St. Charles-the-Martyr	Under 20 0
		St. Andrew	
Rochester	- - - -	Chatham. *See* before.	
	49 Geo. 3. c. 40.	St. Nicholas.	—
	52 Geo. 3. c. 37.	Strood, Intra and Media	14 0
Salisbury	11 Geo. 4. c. 76.	St. Edmund	10 0
		St. Martin	
		St. Thomas	
Southampton	13 Geo. 3. c. 50.	All Saints.	—
		Holyrood.	—
		Portswood.	—
		St. John.	—
		St. Lawrence.	—
		St. Mary.	—
		St. Michael.	—
Southwark	49 Geo. 3. c. 184.	Bermondsey	15 0
	51 Geo. 3. c. 32.	Christchurch	20 0
	10 Geo. 4. c. 131.	Rotherhithe	15 0
	50 Geo. 3. c. 45.	St. George-the-Martyr	20 0
	5 Geo. 4. c. 74.	St. John, Horsleydown.	—
	48 Geo. 3. c. 9.	St. Saviour	20 0
Tower Hamlets	53 Geo. 3. c. 113.	Bethnal Green	14 0
	44 Geo. 3. c. 57.	Bow	10 0
	51 Geo. 3. c. 125.	Bromley	16 0
	50 Geo. 3. c. 190.	Hackney	20 0
	49 Geo. 3. c. 39.	Limehouse	20 0
	53 Geo. 3. c. 37.	Mile End New Town	Under 20 0
	50 Geo. 3. c. 131.	Mile End Old Town	16 0
	50 Geo. 3. c. 5.	Norton Folgate	20 0
	14 Geo. 3. c. 30.	Old Artillery Ground.	—
	50 Geo. 3. c. 83.	Ratcliff	15 0
	51 Geo. 3. c. 153.	St. Botolph-without-Aldgate	20 0
	46 Geo. 3. c. 77.	St. George-in-the-East	15 0
	50 Geo. 3. c. 208.	Shadwell	15 0
	21 & 22 Vict. c. 132.	Shoreditch	15 0
	47 Geo. 3. Sess. 2. c. 30.	Christchurch, Spitalfields	15 0
	52 Geo. 3. c. 75.	Wapping	20 0
	16 & 17 Vict. c. 141.	Whitechapel	12 0

Name of Borough.	Title of Act.	Parishes in which the Act is in force.	Limit of Rental or Value to which the Act applies.
			£ s.
Walsall	13 Vict. c. 15.	Walsall	6 10
Westminster	42 Geo. 3. c. 72.	St. Anne, Soho.	—
	10 Geo. 3.	St. Clement Danes.	—
	7 Geo. 4. c. 121.	St. George, Hanover Square	Under 5 0
	2 Geo. 3. c. 58.	St. James.	—
	25 Geo. 2. c. 23.	St. John-the-Evangelist; St. Margaret.	— —
	10 Geo. 3.	St. Martin-in-the-Fields.	—
	51 Geo. 3. c. 64.	St. Mary-le-Strand	Under 20 0
	10 Geo. 4. c. 68.	St. Paul, Covent Garden	Under 20 0
Wolverhampton	10 Vict. c. 30.	Wolverhampton	Under 6 10 rateable value.
		Bilston	
		Willenhall	
		Wednesfield	

In all 29 Boroughs.

Returns C. and D.

BOROUGHS (MUNICIPAL) UNDER SMALL TENEMENTS RATING ACT.

Abstract 1.

Table showing the Number of Boroughs having the Parliamentary and Municipal Boundaries conterminous in which the Small Tenements Rating Act, 13 & 14 Vict. c. 99., has been wholly or partially adopted; the present Number of Parliamentary Electors and Burgesses in such Boroughs; the Number of Burgesses whose Rates are assessed on the Owner or compounded for by him; and the Number of Burgesses prior to the Adoption of the Act.

Name of Borough.	Number of Parishes in Borough.	Number of Parishes in which Act has been adopted.	Total Number of Electors on Parliamentary Register, 1865-66, including Double Entries.	Total Number of Burgess List, 1865-66.	Number of Burgesses whose Rates are assessed on the Owner or compounded for by him.	Total Number of Burgesses who are in Parliamentary Register, including Duplicate Entries.	Number of Burgesses before the Adoption of the Act. *	Difference between present Number and Number before the Adoption of the Act.	Observations.
1. Abingdon -	2	2	329 S. & L. 20	383	91	309	No return.	—	—
5. Ashton-under-Lyne	1	1	967	2,574	1,816	764	1,790	784	—
8. Barnstaple - -	3	2	763 F. 182	1,158	377	511	No return.	—	—
9. Bath - - -	6	4	3,236 A. R. 1	3,488	25	2,498	3,290	198	—
10. Bedford - -	5	2	1,108 F. 45 A. R. 133	1,703	410	918	No return.	—	—
11. Berwick-upon-Tweed	2	1	816 F. 376	825	198	582	593	232	—
16. Blackburn - -	1	1	1,894	6,486	4,403	1,894	—	—	—
18. Bolton - -	3	2	2,293	8,092	4,769	1,924	2,539	5,553	—
20. Bradford - -	4	3	5,189	19,604	10,844	5,189	5,058	14,546	—
22. Bridgwater - -	3	2	679 S. & L. 41	619	None.	546	503	116	In 1864 the compound occupiers were on the burgess list, and the total number of burgesses was 1,768. This year only those actually rated were placed on the list, and as no claims were made the list remained as returned.
23. Bridport - -	7	4	503 S. & L. 28	716	837	380	No return.	—	—
28. Bury St. Edmunds -	2	2	697 F. 8	1,504	788	615	842	662	—
30. Cambridge - -	14	13	1,926 F. 21	2,615	588	1,580	2,410	205	—
32. Carlisle - -	6	5	1,506 F. 310	3,377	2,450	1,035	2,512	865	—

* The numbers in this column are taken from the Report of the Select Committee of the House of Lords (No. 46., 1859), on the Operation of the Act 13 & 14 Vict. c. 99.

NAME OF BOROUGH.	Number of Parishes in Borough.	Number of Parishes in which Act has been adopted.	Total Number of Electors on Parliamentary Register, 1865–66, including Double Entries.	Total Number of Burgess List, 1865–66.	Number of Burgesses whose Rates are assessed on the Owner or compounded for by him.	Total Number of Burgesses who are in Parliamentary Register, including Duplicate Entries.	Number of Burgesses before the Adoption of the Act.	Difference between present Number and Number before the Adoption of the Act.	OBSERVATIONS.
35. CHESTER - -	14	11	2,700 F. 1,102	3,893	2,312	1,423	1,853	2,040	——
36. CHICHESTER - -	13	7	587 F. 2 S. & L. 26	748	198	390	885	Decrease 137	——
42. COLCHESTER - -	16	14	1,424 F. 405	2,661	1,485	1,131	1,969	692	——
43. COVENTRY - -	2	2	4,967 F. 3,911	4,236	1,893	2,472	1,932	2,304	Not conterminous, but the difference only affects a small number of the Voters.
46. DERBY - -	5	5	2,532 F. 336	6,001	2,304	2,223	2,471	3,530	——
47. DEVIZES - -	4	3	369 A. R. 4	421	103	288	371	50	——
49. DORCHESTER - -	4	1	451	586	112	386	417	169	——
50. DOVER - -	8	3	2,414 F. 839	2,021	213	1,549	No return.	—	——
52. DUDLEY - -	1	1	1,358	6,363	4,339	1,307	No return.	—	——
53. DURHAM - -	10	4	1,149 F. 501	1,245	133	718	1,016	229	——
54. EVESHAM - -	3	3	372 F. 49	617	316	288	419	198	——
59. GATESHEAD - -	2	2	1,172	2,619	1,433	1,094	816	1,803	——
60. GLOUCESTER -	14	9	1,846 F. 548	1,629	398	1,023	1,306	323	——
64. GUILDFORD - -	7	4	725 F. 31 S. & L. 9	600	42	511	462	138	——
65. HALIFAX - -	3	2	1,788	6,100	3,000	1,628	No return.	—	——
67. HASTINGS - -	10	4	1,941 F. 3	1,840	50	1,499	1,221	619	——
69. HEREFORD - -	11	7	1,314 F. 185	1,812	552	943	706	1,106	——
70. HERTFORD - -	6	2	602 F. 96 S. & L. 10	636	148	432	611	25	——
71. HONITON - -	1	1	288 A. R. 60	343	146	227	No return.	—	——
76. IPSWICH - -	22	18	2,237 F. 360	4,297	2,130	1,487	2,397	1,900	——
78. KENDAL - -	3	2	454	1,579	1,049	427	1,434	145	——
86. LEEDS - - -	13	8	8,485	32,877	18,465	8,485	13,627	19,250	——
87. LEICESTER - -	10	7	5,438 F. 1,839 S. & L. 11	4,986	2,120	2,957	2,348	2,638	A Local Act is in force in one of the parishes, the largest one.
88. LEOMINSTER - -	2	2	408 S. & L. 52 A. R. 4	563	232	363	516	47	——

NAME OF BOROUGH.	Number of Parishes in Borough.	Number of Parishes in which Act has been adopted.	Total Number of Electors on Parliamentary Register, 1865–66, including Double Entries.	Total Number of Burgess List, 1865–66.	Number of Burgesses whose Rates are assessed on the Owner or compounded for by him.	Total Number of Burgesses who are in Parliamentary Register, including Duplicate Entries.	Number of Burgesses before the Adoption of the Act.	Difference between present Number and Number before the Adoption of the Act.	OBSERVATIONS.
90. LICHFIELD - -	6	3	720 F. 95 A. R. 211	893	455	438	751	142	—
91. LINCOLN - -	19	6	1,813 F. 546	2,865	1,816	1,152	776	2,089	—
93. LIVERPOOL - -	5	5	21,839 F. 1,285	15,102	614	13,396	12,072	3,030	—
98. MACCLESFIELD -	3	3	964	6,061	5,194	867	1,686	4,375	—
112. NEWCASTLE-UPON-TYNE	9	8	7,460 F. 1,842	9,924	3,551	6,788	4,393	5,531	—
113. NEWPORT, I. OF WIGHT	5	2	664 F. 2	736.	71	565	666	70	—
115. NORTHAMPTON -	5	5	2,857 S. & L. 278	3,867	1,315	2,113	No return.	—	—
117. NOTTINGHAM - -	3	2	6,921 F. 1,565 A. R. 1,027	6,910	2,331	4,031	4,782	2,128	—
124. POOLE - -	4	4	568 F. 12	701	124	552	431	270	—
126. PORTSMOUTH - -	2	2	4,671 F. 1	9,419	4,698	3,089	3,961	5,458	—
127. PRESTON - -	2	1	2,649 A. R. 425	7,991	5,797	1,974	1,892	6,099	—
128. READING - -	3	3	1,832 S. & L. 2	1,468	None.	1,337	No return.	—	The 59 Geo. 3. c. 12. is also stated to be in force, and the limit towhich the composition applies is £10 value.
129. REIGATE - -	2	2	926	966	141	746	No return.	—	—
132. RIPON - -	2	2	349	775	309	316	733	42	—
134. ROCHESTER - -	6	4	1,599 F. 374	1,454	318	1,048	No return.	—	A Local Act, 52 Geo. 3. c. 37., is in force in one of the parishes.
135. RYE - - -	9	6	392 F. 4	445	178	194	297	148	—
136. SALFORD - -	4	4	5,458	8,751	6,028	3,477	Not stated.	—	Under 59 Geo. 3. c. 12. The limit in two parishes is £18, in the third (Salford) £13, and in the fourth £20.
139. SCARBOROUGH -	2	1	1,446 F. 9	2,361	2,056	1,222	837	1,524	—
143. SHREWSBURY - -	6	6	1,777 F. 406	2,495	933	1,267	No return.	—	—
144. SOUTHAMPTON - -	7	6	4,230 F. 4 A.R. 79	3,904	751	2,869	No return.	—	—
145. SOUTH SHIELDS -	2	2	1,211	2,300	1,129	1,170	No return.	—	—
147. STAFFORD - -	2	1	1,639 F. 973	1,411	35	794	No return.	—	The parish in which the Act is adopted forms about one ninth of the Borough
156. TEWKESBURY - -	1	1	342 F. 21 A. R. 9	656	340	279	388	268	—

Name of Borough.	Number of Parishes in Borough.	Number of Parishes in which Act has been adopted.	Total Number of Electors on Parliamentary Register, 1865–66, including Double Entries.	Total Number of Burgess List, 1865–66.	Number of Burgesses whose Rates are assessed on the Owner or compounded for by him.	Total Number of Burgesses who are in Parliamentary Register, including Duplicate Entries.	Number of Burgesses before the Adoption of the Act.	Difference between present Number and Number before the Adoption of the Act.	Observations.
159. Tiverton - -	1	1	465 F. 4	913	434	417	977	64 Decrease.	—
162. Truro - -	3	3	640 F. 1	1,324	721	488	855	469	—
163. Tynemouth - -	5	4	1,271	2,073	233	1,102	1,269	804	—
164. Wakefield -	3	1	1,188	2,165	351	822	—	—	—
168. Warrington -	3	2	779	1,443	200	566	648	803	Not conterminous; but the number of inhabited houses in the Parliamentar Borough in 1861 was onl 101 more than in th Municipal Borough. Th overseers of the townshi of Warrington have thi year omitted the com pounded occupiers, an not one of them has claimed There were 1,710 com pounded occupiers on th Burgess Roll for 1864–65.
169. Warwick - -	2	2	766 S. & L. 125	1,416	719	603	1,111	305	—
174. Weymouth - -	4	3	938 F. 4 A.R. 3	1,157	323	780	644	513	—
177. Wigan - -	1	1	865 A.R. 3	2,931	2,069	862	1,227	1,704	—
179. Winchester - -	21	9	991 A.R. 3	1,233	290	963	994	239	—
180. Windsor - -	2	1	657	731	223	524	653	78	—
183. Worcester - -	15	12	2,676 F. 732	3,052	867	1,546	1,685	1,367	—
185. Yarmouth - -	2	1	1,650	2,408	*388	1,357	1,304	1,104	*The Act was adopted in 185 and rescinded in 1856. has recently been adopte again; and the Town Cler states that if the com pounded occupiers are dul entered in the rate boo the number in this colum will exceed 2,000 nex year.
Totals - -	414	285	152,140	254,118	115,771	111,710	101,338	98,726*	

* This total gives the net increase after deducting the decrease in the cases of Chichester and Tiverton.

Total Number of Burgesses on the Lists 1865–6 for the Boroughs comprised in the foregoing Abstract 1. - - - -	**254,118**
Total Number of Parliamentary Electors - - -	**152,140**
Excess of Burgesses over Parliamentary Electors -	**101,978**
Total Number of Parliamentary Electors - - - - -	**152,140**
Total Number of Burgesses on the Parliamentary Register - -	**111,710**
Number of Parliamentary Electors who are not on the Burgess Lists - - - - -	**40,430**
Total Number of Burgesses on the Lists 1865–6 for those Boroughs in which the Number on the Lists before the adoption of the Small Tenements Act is shown - - - - - -	**200,064**
Total Number on the Lists prior to the adoption of the Small Tenements Act - - - - - - - -	**101,338**
Increase - - - - -	**98,726**

Returns C. and D.

BOROUGHS (MUNICIPAL) UNDER LOCAL ACTS FOR RATING OWNERS.

Abstract 2.

Table showing the Number of Boroughs having the Parliamentary and Municipal Boundaries conterminous in which there are Local Acts in force providing for the Assessment of the Owners of small Tenements instead of the Occupiers; the present Number of Parliamentary Electors and Burgesses; and the Number of Burgesses whose Rates are assessed on the Owner or compounded for by him.

Name of Borough.	Number of Parishes in Borough.	Number in which Act is in force.	Limit of Value to which Act applies.	Total Number of Electors on Parliamentary Register, 1865–66.	Total Number of Burgesses on Lists, 1864–5.	Total Number of Burgesses whose Rates are assessed on the Owner or compounded for by him.	Number of Burgesses on Parliamentary Register.	Observations.
15. Birmingham - -	3	3	£ s. 12 0 7 10 7 0	15,497	17,840*	6,446	11,984	There are three Local Acts in force: 1 & 2 W. 4. c. 67. (Birmingham, 12*l.*), 10 & 11 Vict., 1847 (Edgbaston, 7*l.* 10*s.*), 9 & 10 Vict. c. 225. (Aston, 7*l.*)
25. Bristol - -	24	19 1	under 20 0 and 12 0	14,324 F. 1,707 S. & L. 1,920	11,631	2,568	8,507	A Local Act, 3 Geo. 4. c. 24., limit under 20*l.*, is in force in 19 parishes. Another Local Act, 2 W. 4. c. 89., limit 12*l.*, is in force in one parish, and the Small Tenements Act in the remaining four.
31. Canterbury - -	26	7	10 0	1,808 F. 724	1,576	467	1,060	A Local Act, 54 Geo. 3. c. 114., is in force in seven parishes. The Small Tenements Act in one.
79. Kidderminster -	2	2	10 0 and 7 0	625	1,497†	923	574	There is a Local Act for each parish, 4 & 5 Vict. c. 72., limit under 10*l.*; 12 Vict. c. 12., limit 7*l.*
80. Kings Lynn -	2	2	8 0	901	1,142	None	713	There are two Local Acts in force, 5 Geo. 4. c. 41. in All Saints, 48 Geo. 3. c. 22. in St. Margaret.
81. Kingston-upon-Hull	5	2	under 10 0	6,498 F. 1,358	7,505	1,769	4,547	A Local Act, 5 Geo. 4. c. 13., is in force in Hull, and another Local Act, 4 W. 4. c. 5., in force in Sculcoates. The Small Tenements Act is adopted in the remaining parishes.
99. Maidstone -	1	1	12 0	1,973 F. 401	2,036	1,201	1,328	The Parliamentary and Municipal Boundaries are nearly but not quite conterminous. The Local Act is 45 Geo. 3. c. 118.
116. Norwich - -	44	44	9 0	5,682 F. 1,971 A. R. 1,271	3,383	58	2,666	The Norwich Poor Act, 1863, is in force throughout the City, with a limit of 9*l.*
123. Plymouth - -	2	2	20 0	3,123 F. 14	2,816	15	2,548	53 Geo. 3. c. 73. Not conterminous, but all the Parliamentary Electors and Burgesses reside within the same limits.
137. Salisbury - -	6	3	10 0	704 A. R. 2	691	44	593	The greater portion of the Borough is under a Local Act 11 Geo. 4. c. 76. In one parish the Small Tenements Act has been adopted.
166. Walsall - -	2	2	6 10	1,296	1,470	185	1,092	
Totals - -	117	88	-	52,431	51,587	13,676	35,612	

* The Aston Local Act contains a provision for the protection of the Municipal Franchise.

† The Kidderminster Local Act contains a provision to the same effect.

Total Number of Parliamentary Electors - - - -	52,431
Total Number of Burgesses - - - - -	51,587
Excess of Parliamentary Electors over Burgesses - - -	844
Total Number of Burgesses who are on the Parliamentary Register	35,612
Number of Parliamentary Electors who are not on the Burgess Lists	15,975

Returns C. and D.

BOROUGHS (MUNICIPAL) NOT UNDER THE SMALL TENEMENTS ACT OR ANY LOCAL ACT FOR RATING OWNERS.

Abstract 3.

Table showing the Number of Boroughs having the Parliamentary and Municipal Boundaries conterminous in which there is no Act in force for the Assessment of the Owners of Small Tenements instead of the Occupiers, and the present Number of Parliamentary Electors and Burgesses.

Borough or City.	Total Number of Electors on Parliamentary Register, 1865-66.	Total Number of Burgesses on the Lists, 1865-6.	Number of Burgesses on the Parliamentary Register, including Duplicates.	Number of Inhabited Houses, 1861.
3. Arundel - - -	174 S. & L. 31	337	157	528
45. Dartmouth - -	295 F. 1	339	224	825
66. Harwich - -	389	466	326	811
110. Newark - -	711 S. & L. 171	1,534	662	2,558
111. Newcastle-under-Lyme	1,181 F. 718	1,001	582	2,659
119. Oxford* - -	3,113 F. 951	2,939	2,219	5,234
131. Richmond - -	318 S. & L. 6.	455	217	1,046
133. Rochdale -	1,442	5,356	1,345	7,705
141. Sheffield - -	9,136	23,091	7,937	38,052
148. Stamford - -	527 S. & L. 43	940	470	1,636
150. Stockport - -	1,391	2,798	963	11,255
157. Thetford - -	237 S. & L. 5	673	221	900
160. Totnes - - -	395 F. 6	479	280	793
170. Wells - - -	296 F. 66	424	213	863
Totals - -	19,605	40,832	15,816	74,865

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* The Small Tenements Act does not appear to be in force in any of the Parishes within the City of Oxford. The Local Act 17 & 18 Vict. c. 219. s. 39. applies only to houses let out in separate apartments or ready furnished.

Total Number of Burgesses - - - - - -	- **40,832**
Total Number of Parliamentary Electors - - - -	- **19,605**
Excess of Burgesses over Parliamentary Electors -	- **21,227**
Total Number of Burgesses on Parliamentary Register -	- **15,816**
Number of Parliamentary Electors who are not on the Burgess Lists	- **3,789**

Return [illegible].

PARLIAMENTARY BOROUGHS.—Male Occupiers.

A Return of the Number of Male Persons resident within any Parliamentary City or Borough in England and Wales, or within Seven Miles thereof, and assessed in the Valuation List in force for any Parish within such City or Borough, or if no Valuation List has been approved then in the last Valuation List delivered to the Assessment Committee, with any Alteration made by them therein, or where there is no such List then in the last Poor Rate, as Occupiers of a House or other Building either with or without Land within the City or Borough at the Gross Estimated Rental and Rateable Value of £4 and upwards respectively as under; and also of the Number of Inhabited Houses in each such City or Borough in 1861, and the actual Number of Electors on the Parliamentary Register for 1865-6 as £10 Occupiers.

Name of City or Borough.	Gross Estimated Rental. Male Occupiers.							Rateable Value. Male Occupiers.								Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865-6 as £10 Occupiers.
	At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	At £4 and under £5.	At £5 and under £6.	* At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.		
ENGLAND.																	
1. Abingdon	64	168	153	92	26	55	361	141	134	1	—	2	118	23	253	1,189	304
2. Andover	245	93	48	23	29	11	272	50	35	3	34	15	21	17	224	1,102	255
3. **ARUNDEL** †	63	59	41	17	11	17	134	96	27	8	16	16	19	7	113	528	143
4. Ashburton	22	10	42	56	82	65	245	55	63	5	54	97	42	38	147	574	349
5. Ashton-under-Lyne	602	1,683	560	329	158	74	878	1,015	1,503	23	311	189	101	83	864	6,460	967
6. Aylesbury	637	324	202	118	94	116	1,300	354	177	25	127	102	155	111	1,154	5,718	1,183
7. Banbury	172	187	303	122	107	27	779	258	311	39	69	53	114	42	647	2,068	614
8. Barnstaple	262	89	106	84	61	40	689	126	88	60	39	86	39	44	512	2,186	581
9. Bath	137	252	295	431	226	171	4,268	322	206	85	306	178	425	76	3,887	8,017	2,960
10. Bedford	210	196	336	178	94	55	1,188	416	267	30	101	53	337	99	791	2,752	930

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* The 13 & 14 Vict. c. 99., usually known as "The Small Tenements Act," fixes *a yearly rateable value, not exceeding £6*, as the highest amount at which the owners may be rated instead of the occupiers.

† The Boroughs in this type are not, either as to the whole or some part of their area, within any Union, and consequently are not rated under the Union Assessment Committee Act, 1862.

Name of City or Borough.	Gross Estimated Rental. Male Occupiers.							Rateable Value. Male Occupiers.								Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865-6 as £10 Occupiers.
	At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.		
11. Berwick-upon-Tweed	189	70	88	22	24	14	508	22	38	12	16	30	18	67	452	1,883	437
12. Beverley	287	416	111	91	77	40	638	421	141	42	42	74	79	63	517	2,403	592
13. Bewdley	209	162	84	37	80	22	546	100	35	1	70	33	64	43	412	1,598	355
14. Birkenhead	72	418	166	452	545	344	6,829	315	270	371	145	491	322	708	6,213	7,189	4,563
15. **BIRMINGHAM**	2,909	8,817	10,369	7,210	6,367	1,382	19,062	14,049	10,132	3,170	3,206	3,035	1,557	1,545	15,852	59,060	14,997
16. Blackburn	1,364	3,009	1,937	347	349	437	1,798	3,026	1,741	220	479	372	361	302	1,357	11,306	1,894
17. Bodmin	122	39	49	26	20	9	377	67	32	12	13	52	29	20	286	1,191	397
18. Bolton	1,955	2,397	1,896	1,111	619	240	2,737	3,074	1,727	656	556	383	638	234	1,941	13,129	2,186
19. Boston	490	504	413	140	54	107	874	635	339	50	39	125	74	80	755	3,901	916
20. Bradford	1,779	3,920	4,835	1,302	1,447	334	6,170	5,093	4,226	679	596	1,474	611	435	5,024	22,518	5,189
21. Bridgnorth	205	193	99	44	47	16	410	239	136	—	51	69	51	40	369	1,570	374
22. Bridgwater	269	276	193	183	185	—	750	301	243	179	1	2	237	32	525	2,123	638
23. Bridport	103	203	95	82	45	6	536	233	90	51	42	13	138	47	323	1,581	456
24. **BRIGHTON**	213	246	497	379	612	572	8,627	244	477	357	65	843	656	585	7,800	13,983	5,978
25. **BRISTOL**	875	1,563	1,364	1,477	1,420	1,214	13,962	1,848	1,576	1,483	804	1,028	1,580	1,175	11,331	23,590	9,929
26. Buckingham	151	112	60	37	29	14	387	62	53	12	24	8	43	15	361	1,706	391
27. Bury	871	1,217	1,262	635	260	198	1,591	1,404	1,590	—	445	229	282	167	1,228	7,257	1,352
28. **BURY ST. EDMUNDS**	300	333	504	39	103	25	741	386	562	4	106	44	129	16	650	2,852	673

Name of City or Borough.	GROSS ESTIMATED RENTAL. Male Occupiers. At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	RATEABLE VALUE. Male Occupiers. At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865–6 as £10 Occupiers.
29. Calne - - -	212	105	48	27	17	4	190	138	52	21	9	12	17	12	165	1,105	172
30. Cambridge - -	295	206	349	562	237	133	1,970	329	459	493	334	165	299	112	1,573	5,388	1,762
31. **CANTERBURY** -	287	409	368	387	418	227	1,349	301	167	62	119	87	179	66	1,047	3,908	1,067
32. Carlisle - -	963	558	440	232	161	78	947	597	272	96	153	108	123	77	892	5,140	1,052
33. Chatham - -	275	408	650	733	398	202	2,817	839	428	370	444	227	1,164	296	1,261	5,185	2,104
34. Cheltenham - -	135	355	365	357	495	189	3,495	716	357	—	484	196	532	186	2,678	7,012	2,793
35. **CHESTER** - -	760	477	1,037	326	131	81	1,612	933	1,079	298	138	110	183	27	1,404	5,971	1,428
36. **CHICHESTER** -	107	184	235	57	123	29	548	162	24	6	52	134	65	4	527	1,601	544
37. Chippenham - -	130	178	116	68	50	27	465	178	62	22	36	96	17	37	299	1,345	392
38. Christchurch - -	91	102	114	51	34	30	517	184	111	15	35	29	41	24	429	1,832	419
39. Cirencester - -	146	122	108	60	37	11	436	200	87	28	48	39	96	39	383	1,300	416
40. Clitheroe - - -	287	385	176	119	32	32	540	429	158	9	115	44	89	31	430	2,247	438
41. Cockermouth - -	307	151	82	29	46	14	408	184	65	—	24	19	48	26	343	1,543	336
42. Colchester - -	454	524	375	326	175	62	1,239	583	435	150	106	122	124	100	1,016	4,447	1,007
43. **COVENTRY** - -	777	736	1,061	1,638	474	541	2,120	1,164	1,073	1,499	373	505	489	193	1,612	9,154	1,056
44. Cricklade - -	550	404	223	162	160	150	2,161	399	248	40	163	241	187	133	1,727	7,676	1,978
45. Dartmouth - -	74	27	40	17	43	15	437	48	23	26	33	18	111	54	312	825	281
46. Derby - - - -	720	1,128	585	1,488	582	432	2,619	1,102	1,545	386	589	495	583	230	1,755	8,991	2,195

Name of City or Borough.	GROSS ESTIMATED RENTAL. Male Occupiers.							RATEABLE VALUE. Male Occupiers.								Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865–6 as £10 Occupiers.
	At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.		
47. Devizes - - -	117	126	141	24	49	14	374	158	92	28	28	22	41	22	316	1,336	359
48. **DEVONPORT** -	52	53	86	52	105	29	3,919	130	37	135	14	320	125	263	3,226	5,434	2,820
49. Dorchester - -	129	97	48	36	34	19	447	142	32	12	35	16	57	31	371	1,030	432
50. Dover - - -	24	83	175	211	298	170	2,340	230	275	125	310	212	495	122	1,849	3,991	1,570
51. Droitwich - -	253	317	98	49	42	15	391	398	61	4	43	17	41	18	343	1,504	398
52. Dudley - - -	749	2,126	2,161	718	392	142	1,389	2,183	816	323	177	55	416	178	795	8,714	1,358
53. Durham - - -	223	216	175	89	91	55	828	154	184	32	114	71	99	32	667	2,007	625
54. Evesham - - -	165	123	66	35	30	9	329	172	33	—	33	7	36	6	287	967	308
55. **EXETER** - -	604	593	363	336	296	240	2,766	554	535	139	167	348	293	251	2,667	6,854	1,665
56. Eye - - -	241	91	28	30	27	16	307	65	36	23	13	31	23	28	288	1,405	328
57. **FINSBURY** - -	121	103	336	170	696	299	39,668	746	560	962	98	550	1,087	305	36,799	44,410	25,461
58. Frome - - -	290	193	70	63	21	87	405	221	93	—	32	19	123	38	332	2,066	414
59. Gateshead - -	1,293	846	875	495	399	182	1,466	388	141	40	16	223	150	60	1,190	4,391	1,165
60. Gloucester - -	224	215	273	190	185	65	1,698	263	94	142	65	255	60	137	1,290	2,854	1,255
61. Grantham - - -	255	247	370	182	56	44	700	274	459	19	122	63	107	96	573	2,254	586
62. Greenwich - -	591	850	854	842	899	1,213	13,216	850	1,147	787	344	1,075	1,364	1,246	11,107	19,365	9,805

Name of City or Borough.	Gross Estimated Rental. Male Occupiers. At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	Rateable Value. Male Occupiers. At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865–6 as £10 Occupiers.
63. Grimsby, Great - -	547	734	311	178	184	95	753	953	380	127	140	139	144	98	638	3,161	1,006
64. Guildford - -	26	58	73	116	67	80	786	77	99	96	48	150	110	70	485	1,466	666
65. Halifax - - -	1,018	918	641	291	250	254	1,988	1,113	401	92	298	298	165	116	1,559	7,807	1,771
66. Harwich - -	36	58	43	20	23	24	451	44	36	19	7	36	100	46	298	811	386
67. Hastings - -	16	63	102	126	77	95	2,269	116	59	16	119	135	193	139	1,955	3,290	1,870
68. Helston - - -	81	88	56	33	41	23	384	91	41	23	18	33	40	40	315	1,683	346
69. Hereford - -	114	286	317	253	163	110	1,176	352	329	146	120	126	194	82	916	3,005	1,098
70. Hertford - -	87	149	104	86	73	42	582	165	148	40	41	49	87	58	402	1,227	486
71. Honiton - - -	84	40	16	20	12	21	254	14	18	2	12	34	25	23	191	714	228
72. Horsham - -	153	236	139	34	46	64	405	103	156	1	114	27	38	51	364	1,267	400
73. Huddersfield - -	837	1,072	709	352	234	164	2,102	1,122	622	112	264	182	208	135	1,775	6,955	2,138
74. Huntingdon - -	140	116	128	92	56	31	416	174	115	25	40	34	47	8	383	1,285	360
75. Hythe - - -	205	222	272	232	75	139	1,203	256	247	133	148	128	118	80	1,011	2,843	1,251
76. Ipswich - - -	772	1,073	1,669	530	135	124	2,260	780	1,413	688	356	147	266	169	1,896	8,272	1,803
77. Ives, St. - -	425	196	117	75	63	28	545	118	84	7	55	33	152	33	347	2,116	442
78. Kendal - - -	371	191	90	60	58	27	466	219	88	40	57	37	57	34	391	2,590	439
79. Kidderminster - -	696	467	293	84	43	6	726	717	99	1	21	28	192	35	524	3,354	612

Name of City or Borough.	GROSS ESTIMATED RENTAL. Male Occupiers.							RATEABLE VALUE. Male Occupiers.								Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865-6 as £10 Occupiers.
	At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.		
80. Kings Lynn - -	243	262	191	105	142	72	867	380	213	8	84	173	101	110	535	3,637	793
81. **KINGSTON-UPON-HULL** - - - -	1,981	2,601	2,494	1,740	1,734	998	7,119	3,552	2,156	1,853	14	765	846	432	4,960	19,516	4,871
82. Knaresborough - -	77	56	51	28	23	9	314	61	26	18	14	55	8	46	210	1,318	272
83. **LAMBETH** - -	86	181	825	736	1,144	1,199	38,543	1,536	1,506	1,432	562	2,186	2,435	1,610	31,750	44,529	27,754
84. Lancaster - -	268	475	366	300	207	89	754	485	355	138	261	169	108	52	599	2,992	464
85. Launceston - -	49	36	34	11	24	11	355	42	19	16	9	21	16	23	301	1,020	371
86. **LEEDS** - - -	9,549	6,645	4,171	2,216	1,072	664	9,337	8,412	4,670	1,542	1,243	972	1,220	426	7,960	44,651	7,217
87. Leicester - - -	1,199	1,599	2,958	1,696	752	494	4,369	2,219	3,449	81	843	1,018	294	567	2,935	14,595	3,348
88. Leominster - -	176	183	78	45	35	13	399	90	15	29	40	14	39	19	330	1,157	337
89. Lewes - - -	85	183	245	141	106	54	778	182	343	24	57	128	123	77	561	1,820	650
90. Lichfield - -	151	128	200	119	45	45	384	217	178	23	35	39	55	36	314	1,456	397
91. Lincoln - - -	328	479	760	570	271	157	1,294	1,016	618	182	277	180	308	124	916	4,315	1,218
92. Liskeard - -	124	95	129	42	57	11	468	111	127	55	48	32	48	23	435	1,146	434
93. **LIVERPOOL** - -	281	1,047	3,152	5,245	5,935	4,737	40,079	989	3,329	7,040	—	6,015	5,140	4,439	38,920	65,781	19,714
94. London, City of -	4	36	47	15	21	10	12,652	2	29	29	59	17	60	32	12,555	13,298	11,580
95. Ludlow - -	89	158	92	29	36	4	423	111	11	3	28	5	99	35	286	1,253	379
96. Lyme Regis - -	75	50	34	20	20	27	317	64	29	9	18	43	46	28	229	683	249
97. Lymington - -	75	101	121	61	24	4	408	43	106	39	25	4	113	45	289	1,025	347

Name of City or Borough.	GROSS ESTIMATED RENTAL. Male Occupiers. At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	RATEABLE VALUE. Male Occupiers. At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865–6 as £10 Occupiers.
98. Macclesfield - -	506	1,396	950	471	227	65	1,055	1,475	890	402	190	79	35	284	868	8,342	861
99. Maidstone - -	210	420	441	296	370	325	2,193	360	525	246	61	632	507	213	1,529	4,119	1,572
100. Maldon - -	161	225	141	156	43	23	320	304	203	74	26	33	42	32	249	1,329	304
101. Malmesbury - -	190	138	63	42	29	20	352	172	36	10	26	19	36	34	325	1,406	322
102. Malton - -	110	83	59	36	35	10	497	95	97	12	36	23	57	13	416	1,694	589
103. **MANCHESTER** -	3,988	7,216	6,922	6,599	5,875	2,656	27,906	7,792	9,737	1,252	5,318	3,743	5,175	3,682	20,047	65,375	21,542
104. Marlborough -	68	109	103	44	23	14	271	167	84	5	25	16	38	25	210	821	275
105. Marlow, Great -	207	153	72	27	23	15	359	189	52	8	22	19	30	43	271	1,284	326
106. **MARYLEBONE** -	1	38	40	116	121	234	35,185	41	60	146	20	101	359	147	35,111	47,896	23,588
107. Midhurst - -	221	93	62	28	37	13	329	39	34	3	49	15	31	9	268	1,282	309
108. Monmouth - -	216	197	165	160	241	170	2,714	256	171	162	177	318	344	454	1,648	5,154	2,077
109. Morpeth - -	280	91	65	40	52	16	455	107	76	19	47	31	38	24	391	2,312	377
110. Newark - -	537	238	199	151	66	42	653	327	218	34	121	58	70	55	573	2,558	540
111. Newcastle-under-Lyme	524	545	298	123	59	20	609	555	374	—	93	38	79	17	506	2,659	463
112. Newcastle-upon-Tyne -	2,934	2,037	1,952	1,242	1,486	1,211	6,827	5,891	1,801	1,269	1,349	1,304	1,524	1,502	6,456	13,979	5,197
113. **NEWPORT (ISLE OF WIGHT)** -	100	65	94	136	110	81	795	92	101	140	42	89	127	75	643	1,591	643
114. Northallerton -	93	44	38	20	17	10	562	66	55	1	17	12	31	69	453	1,058	441
115. Northampton - -	165	346	525	608	993	299	3,233	927	1,092	341	279	910	349	396	1,869	6,150	2,511

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	At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.		
116. **NORWICH** - -	180	217	211	201	296	211	4,393	2,710	2,012	167	1,340	1,235	473	625	3,602	17,112	2,330
117. Nottingham - -	1,740	1,945	1,825	2,214	1,123	681	4,919	3,506	1,354	1,773	450	1,819	1,456	1,035	4,298	15,441	4,270
118. Oldham - -	2,070	1,611	3,078	2,849	979	255	3,342	4,888	2,780	255	473	446	336	209	2,278	18,335	2,285
119. **OXFORD** - -	47	239	358	370	254	347	2,799	444	553	342	84	125	532	340	2,027	5,234	2,162
120. Penryn and Falmouth	161	99	95	61	85	41	1,266	99	58	55	37	150	85	127	897	2,238	788
121. Peterborough -	205	254	283	454	109	46	678	306	374	380	128	139	96	47	588	2,401	608
122. Petersfield - -	187	101	44	12	13	4	350	38	10	3	15	3	36	24	273	1,135	296
123. **PLYMOUTH** - -	68	43	31	39	50	54	3,629	200	183	261	53	227	396	129	3,228	6,084	2,936
124. Poole - - -	343	176	102	21	89	12	616	317	23	—	117	10	152	39	512	2,034	517
125. **PONTEFRACT** -	281	104	67	63	28	38	617	270	106	16	52	62	30	47	609	2,596	624
126. Portsmouth - -	198	1,561	2,040	2,778	1,088	1,174	5,849	1,549	1,940	2,695	543	1,535	1,415	553	4,790	15,819	4,670
127. Preston - -	1,222	3,032	2,130	1,562	781	269	2,537	5,082	1,676	458	869	319	247	297	2,370	15,050	2,224
128. Reading - -	459	149	296	463	44	61	2,687	147	393	213	166	73	514	272	1,886	4,859	1,769
129. Reigate - -	31	29	124	34	103	162	970	33	134	89	33	157	199	65	753	1,583	920
130. Retford, East - -	1,617	1,003	431	206	150	164	2,701	1,247	384	26	183	187	140	180	2,466	10,362	2,371
131. Richmond - -	116	71	51	34	33	21	319	72	70	5	36	18	33	11	272	1,046	312
132. Ripon - - -	251	183	87	40	42	8	427	174	156	67	18	41	34	8	387	1,382	348
133. Rochdale - -	1,112	1,867	935	700	176	71	1,858	1,768	1,304	93	370	88	155	141	1,438	7,705	1,358

Name of City or Borough.	Gross Estimated Rental. Male Occupiers.							Rateable Value. Male Occupiers.								Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865–6 as £10 Occupiers.
	At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.		
134. Rochester - -	97	185	251	377	279	145	1,477	343	316	182	217	247	393	131	1,039	3,074	1,203
135. Rye - - -	221	83	90	169	132	53	345	148	198	9	104	62	40	19	276	1,684	370
136. Salford - -	2,143	2,867	2,061	2,760	1,127	1,088	5,061	2,283	2,394	1,077	1,527	1,080	1,058	442	4,270	19,128	5,397
137. **SALISBURY** - -	64	167	281	258	90	179	813	919	97	58	19	30	38	97	674	2,344	690
138. Sandwich - -	182	297	286	185	148	61	943	424	210	118	123	76	116	110	655	2,672	841
139. Scarborough - -	468	398	274	232	95	137	1,965	492	323	56	101	124	286	151	1,562	3,940	1,348
140. Shaftesbury - -	184	86	58	35	34	20	452	128	38	14	26	20	36	14	410	1,928	446
141. Sheffield - -	3,297	6,564	9,335	3,224	2,055	1,572	10,160	11,777	6,360	1,067	1,719	1,803	1,173	1,031	7,153	38,052	8,557
142. Shoreham, New -	873	816	329	172	189	137	1,919	459	206	53	171	151	219	131	1,625	5,930	1,906
143. **SHREWSBURY** -	371	532	614	304	149	110	1,657	393	511	428	400	294	143	127	1,579	4,445	1,321
144. **SOUTHAMPTON** -	6	24	64	152	75	397	6,554	202	390	1,411	35	132	540	370	4,522	7,712	4,117
145. South Shields - -	1,598	859	1,137	236	360	180	1,271	1,486	761	1,566	1,076	223	349	206	1,193	4,443	1,113
146. **SOUTHWARK** - -	105	458	706	930	1,189	1,220	17,649	1,590	1,399	911	382	920	1,010	1,216	12,552	25,659	11,575
147. Stafford - -	205	250	564	313	174	83	783	245	673	—	303	170	111	49	543	2,241	657
148. Stamford - -	273	145	51	38	55	10	447	142	83	27	36	25	56	7	418	1,636	471
149. **STOKE-UPON-TRENT** - - }	2,359	3,675	4,626	1,814	684	444	3,419	3,988	5,107	293	1,469	730	439	194	2,947	19,855	3,189
150. Stockport - -	1,391	1,402	1,630	585	279	158	1,695	1,508	1,540	120	617	268	46	393	1,339	11,255	1,348
151. Stroud - - -	1,128	593	296	149	175	80	1,483	985	210	19	170	75	191	121	1,252	8,183	1,356
152. Sunderland - -	1,823	2,261	1,870	1,697	809	432	4,657	2,295	2,183	930	1,059	611	594	189	4,006	11,188	3,468

Name of City or Borough.	Gross Estimated Rental. Male Occupiers. At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	Rateable Value. Male Occupiers. At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865–6 as £10 Occupiers.
153. Tamworth - - -	477	255	35	52	55	28	548	209	102	14	51	36	54	44	450	2,103	504
154. Taunton - -	493	199	393	132	94	61	1,123	504	194	6	100	79	166	47	861	2,899	812
155. Tavistock - -	106	71	273	23	16	10	459	73	250	14	19	18	12	24	414	1,133	424
156. Tewkesbury - -	89	225	64	27	18	10	413	279	47	8	22	13	78	33	282	1,268	312
157. Thetford - -	115	45	43	6	48	13	187	30	14	2	45	16	43	13	127	900	224
158. Thirsk - - -	167	54	40	33	29	22	385	66	47	22	27	37	29	29	340	1,205	380
159. Tiverton - -	207	146	74	63	47	23	434	174	101	32	33	43	45	42	375	2,210	461
160. Totnes - - -	87	76	35	24	8	6	516	126	80	35	27	22	33	11	435	793	379
161. **TOWER HAMLETS**	824	1,297	2,076	3,269	4,682	3,173	75,137	5,953	5,921	4,041	2,994	4,928	5,595	3,369	56,009	88,310	34,115
162. Truro - - -	402	252	224	135	138	54	732	181	63	72	27	160	18	66	499	2,391	557
163. Tynemouth - -	957	343	251	156	265	254	1,664	137	79	79	91	255	217	200	1,210	4,952	1,271
164. Wakefield - -	981	744	449	198	93	61	1,364	742	547	3	102	63	254	57	1,064	4,773	1,086
165. Wallingford - -	213	149	79	25	24	19	393	179	54	1	42	21	72	42	278	1,657	355
166. Walsall - - -	1,076	809	1,266	1,068	669	409	1,801	1,752	1,139	10	610	425	283	222	1,306	7,445	1,296
167. Wareham - - -	133	84	73	32	37	19	344	132	68	18	40	42	56	47	291	1,339	271
168. Warrington - - -	1,041	1,022	619	258	258	111	1,071	971	710	175	148	348	77	156	934	5,146	768
169. Warwick - -	292	260	253	163	67	70	740	213	305	21	61	73	119	68	515	2,272	639
170. Wells - - -	92	82	59	20	22	12	306	94	59	18	6	23	48	18	236	863	227
171. Wenlock - -	508	555	292	137	82	55	930	716	218	4	129	106	70	75	776	4,369	842

Name of City or Borough.	GROSS ESTIMATED RENTAL. Male Occupiers.							RATEABLE VALUE. Male Occupiers.								Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865–6 as £10 Occupiers.
	At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.		
172. Westbury - -	284	129	65	49	19	54	326	152	50	18	17	31	50	26	320	1,526	300
173. **WESTMINSTER** -	49	181	169	440	214	138	19,116	49	182	436	—	150	294	68	19,112	26,286	12,386
174. Weymouth - -	62	152	101	37	46	13	1,066	259	30	5	46	15	269	168	631	1,864	906
175. Whitby - -	361	187	129	67	50	35	852	178	87	27	65	45	151	41	694	2,464	703
176. Whitehaven - -	568	599	343	132	112	81	887	734	213	15	128	91	133	48	608	3,751	648
177. Wigan - - -	1,450	1,577	1,035	735	39	34	1,302	1,291	867	588	29	32	175	38	950	6,696	862
178. Wilton - - -	191	122	50	44	38	16	349	98	29	33	34	26	28	17	260	1,814	265
179. Winchester - -	48	103	191	251	112	65	1,058	174	301	53	129	70	180	90	828	2,392	963
180. Windsor - - -	27	61	48	75	65	50	951	76	90	44	73	179	20	65	673	1,577	651
181. Wolverhampton -	2,171	4,710	3,824	4,639	1,444	643	5,645	5,251	5,708	381	1,394	1,289	1,265	664	4,786	28,432	4,830
182. Woodstock - -	243	139	69	22	29	9	300	209	27	19	15	21	12	35	243	1,663	277
183. Worcester - -	329	574	636	660	443	318	2,786	744	776	367	100	330	395	176	2,132	6,330	1,838
184. Wycombe - -	234	254	152	114	88	29	538	253	124	33	70	34	77	56	368	1,703	550
185. **YARMOUTH** -	827	1,182	1,294	627	277	93	2,080	122	60	20	349	86	372	172	1,397	7,792	1,645
186. York - - -	918	914	852	631	387	287	3,579	914	852	399	495	353	405	175	3,107	9,162	2,052
Total of Metropolitan Boroughs -	1,190	2,294	4,199	5,676	8,067	6,273	237,950	9,917	9,657	7,957	4,115	8,852	10,840	6,747	203,888	290,388	146,459
Total of **ENGLAND** (exclusive of Metropolitan Boroughs)	99,545	123,014	119,884	85,620	58,948	35,737	384,850	160,322	120,825	46,376	43,920	50,202	52,593	35,811	312,621	1,092,600	292,737
Total of **ENGLAND** -	100,735	125,308	124,083	91,296	67,015	42,010	622,800	170,239	130,482	54,333	48,035	59,054	63,433	42,558	516,509	1,382,988	439,196

Name of City or Borough.	GROSS ESTIMATED RENTAL. Male Occupiers.							RATEABLE VALUE. Male Occupiers.								Number of Inhabited Houses, 1861.	Actual Number of Electors on Register for 1865-6 as £10 Occupiers.
	At £4 and under £5.	At £5 and under £6.	At £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.	At £4 and under £5.	At £5 and under £6.	At £6.	Above £6 and under £7.	At £7 and under £8.	At £8 and under £9.	At £9 and under £10.	At £10 and over.		
WALES.																	
187. Beaumaris - -	147	103	60	128	73	40	414	269	138	66	119	47	55	28	312	2,942	557
188. Brecon - -	34	24	61	22	48	26	296	19	20	9	44	10	31	10	292	1,227	281
189. Cardiff - -	109	175	401	266	323	93	3,425	182	399	67	370	151	259	202	3,063	5,152	1,879
190. Cardigan - -	131	110	104	89	62	61	570	158	174	27	92	97	45	69	476	2,580	636
191. Carmarthen - -	106	381	444	266	175	78	979	464	404	279	69	160	137	22	818	3,963	775
192. Carnarvon - -	744	344	248	205	163	94	1,078	387	240	75	115	141	108	92	828	4,929	1,027
193. Denbigh - -	491	288	138	112	121	73	994	282	128	70	96	133	75	69	746	3,689	805
194. Flint - - -	587	256	136	76	91	29	751	366	87	22	77	49	24	79	646	4,188	601
195. Haverfordwest -	248	249	154	88	55	36	512	323	146	37	53	66	86	39	425	2,102	404
196. Merthyr Tydfil -	2,683	2,949	2,605	370	282	131	1,588	3,085	2,549	378	53	178	155	79	1,522	16,114	1,387
197. Montgomery - -	411	230	158	131	89	64	984	424	167	105	68	82	123	58	840	4,077	935
198. Pembroke - -	270	330	366	260	186	137	1,355	639	288	73	167	146	211	134	1,066	3,434	1,101
199. Radnor - - -	150	76	73	21	27	21	424	261	55	15	25	51	23	41	410	1,423	420
200. Swansea - -	1,559	939	1,262	714	437	316	2,873	432	357	110	556	252	503	132	2,632	10,636	1,695
Total WALES - -	7,670	6,454	6,210	2,748	2,132	1,199	16,243	7,291	5,152	1,333	1,904	1,563	1,835	1,054	14,076	66,456	12,503
Total ENGLAND and WALES - -	108,405	131,762	130,293	94,044	69,147	43,209	639,043	177,530	135,634	55,666	49,939	60,617	65,268	43,612	530,585	1,449,444	451,699

Return F.

BOROUGHS:—Gross Estimated Rental and Rateable Value.

A Return showing the Gross Estimated Rental and Rateable Value according to the Valuation Lists or last Poor Rates of all the Rateable Property within the several Parliamentary Boroughs of England and Wales as compared with the Gross Estimated Rental and Rateable Value at Lady Day 1856; also the Gross Estimated Value according to the Income Tax Assessment under Schedule A. of such Property, omitting Railways and other Properties assessed upon Profits; and the Gross Estimated Rental of the same Property, with a similar omission, according to the Valuation Lists or last Poor Rates.

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
ENGLAND.	£	£	£	£	£	£	£	£	£	£
1. Abingdon - -	14,119	17,028	2,909	—	11,300	12,887	1,587	—	18,340	16,668
2. Andover - - -	22,467	27,096	4,629	—	18,509	23,127	4,618	—	27,876	26,259
3. Arundel - -	10,318	10,964	646	—	7,881	7,988	107	—	11,383	10,964
4. Ashburton - - -	13,469	13,027	—	442	9,819	10,778	959	—	14,044	12,822
5. Ashton-under-Lyne -	81,975	105,590	23,615	—	65,789	83,471	17,682	—	109,305	97,141
6. Aylesbury - -	103,178	135,363	32,185	—	91,226	123,187	31,961	—	142,624	133,582
7. Banbury - - -	39,486	49,423	9,937	—	31,083	40,350	9,267	—	49,906	46,680
8. Barnstaple - -	35,253	33,087	—	2,166	24,841	25,372	531	—	33,994	31,821
9. Bath - - -	273,482	280,476	6,994	—	232,733	239,998	7,265	—	270,284	266,010
10. Bedford - - -	40,383	58,397	18,014	—	35,948	47,733	11,785	—	54,283	55,844

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. — See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
11. Berwick-upon-Tweed -	44,996	47,825	2,829	—	41,265	41,064	—	201	38,941	38,236
12. Beverley - -	44,857	50,180	5,323	—	41,731	43,353	1,622	—	46,860	45,974
13. Bewdley - -	26,195	26,438	243	—	21,417	23,047	1,630	—	24,251	25,758
14. Birkenhead - -	New Borough	299,244	—	—	—	269,551	—	—	270,667	264,573
15. Birmingham - -	988,563	1,189,483	200,920	—	792,764	966,363	173,599	—	1,171,296	1,101,313
16. Blackburn - -	126,373	176,451	50,078	—	118,476	144,598	26,122	—	201,355	165,713
17. Bodmin - -	22,256	24,711	2,455	—	17,731	21,780	4,049	—	26,938	24,082
18. Bolton - - -	178,882	226,476	47,594	—	149,078	184,488	35,410	—	240,314	213,713
19. Boston - -	51,076	68,560	17,484	—	46,237	56,400	10,163	—	74,866	63,923
20. Bradford - -	336,508	452,450	115,942	—	262,610	378,053	115,443	—	451,294	424,026
21. Bridgnorth - -	32,363	34,434	2,071	—	28,271	31,831	3,560	—	34,019	33,641
22. Bridgwater - -	28,747	33,075	4,328	—	19,638	27,351	7,713	—	32,392	31,142
23. Bridport - -	19,966	21,133	1,167	—	16,218	17,191	973	—	24,837	20,823
24. Brighton - -	455,775	541,388	85,613	—	382,259	453,802	71,543	—	610,015	527,919
25. Bristol - - -	535,873	650,123	114,250	—	459,659	553,497	93,838	—	625,256	610,087
26. Buckingham - -	35,675	45,416	9,741	—	30,536	40,844	10,308	—	47,264	44,738
27. Bury - - -	112,884	131,595	18,711	—	86,014	124,772	38,758	—	127,163	116,537
28. Bury St. Edmunds -	49,475	49,915	440	—	37,737	41,878	4,141	—	50,937	48,693

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
29. CALNE - - -	24,406	25,219	813	—	21,453	22,585	1,132	—	26,990	24,863
30. CAMBRIDGE - -	127,329	133,558	6,229	—	98,579	114,500	15,921	—	112,009	106,337
31. CANTERBURY - -	64,630	71,452	6,822	—	51,018	57,056	6,038	—	79,937	69,494
32. CARLISLE - -	75,226	82,206	6,980	—	59,433	70,106	10,673	—	93,610	73,369
33. CHATHAM - - -	53,279	79,152	25,873	—	44,034	69,575	25,541	—	80,356	76,824
34. CHELTENHAM - -	190,000	230,939	40,939	—	164,900	196,108	31,208	—	224,688	224,520
35. CHESTER - - -	80,688	114,127	33,439	—	63,824	93,996	30,172	—	103,979	102,890
36. CHICHESTER - -	29,126	30,042	916	—	24,265	24,187	—	78	36,699	29,426
37. CHIPPENHAM - -	39,418	41,034	1,616	—	26,926	33,771	6,845	—	35,557	35,652
38. CHRISTCHURCH - -	44,755	58,911	14,156	—	34,431	49,698	15,267	—	58,438	58,645
39. CIRENCESTER - -	20,276	29,179	8,903	—	17,297	24,314	7,017	—	28,897	28,679
40. CLITHEROE - - -	34,578	45,327	10,749	—	29,612	38,658	9,046	—	46,162	43,605
41. COCKERMOUTH - -	25,299	29,953	4,654	—	21,274	26,069	4,795	—	28,854	28,116
42. COLCHESTER - -	64,016	88,359	24,343	—	48,475	72,031	23,556	—	88,971	82,403
43. COVENTRY - -	124,359	139,134	14,775	—	107,074	117,091	10,017	—	141,822	130,718
44. CRICKLADE - -	255,622	313,347	57,725	—	204,262	259,005	54,743	—	299,119	268,334

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. — See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
45. Dartmouth - -	14,672	15,226	554	—	10,987	12,378	1,391	—	16,576	14,879
46. Derby - - -	151,673	154,701	3,028	—	126,282	124,827	—	1,455	154,510	147,648
47. Devizes - - -	21,073	23,481	2,408	—	16,959	19,716	2,757	—	23,525	22,550
48. Devonport - -	114,737	132,597	17,860	—	87,879	102,484	14,605	—	133,060	130,129
49. Dorchester - -	20,134	20,455	321	—	14,571	16,368	1,797	—	26,070	19,808
50. Dover - - -	86,877	109,758	22,881	—	75,248	91,178	15,930	—	113,267	104,803
51. Droitwich - -	52,186	63,714	11,528	—	45,632	55,583	9,951	—	51,983	50,488
52. Dudley - - -	86,571	142,191	55,620	—	60,663	103,876	43,213	—	88,430	105,052
53. Durham - - -	31,071	40,430	9,359	—	24,581	32,917	8,336	—	38,560	37,820
54. Evesham - -	18,585	19,562	977	—	14,656	17,138	2,482	—	19,736	18,983
55. Exeter - -	180,795	178,436	—	2,359	139,100	154,273	15,173	—	180,553	167,387
56. Eye - - -	39,818	42,917	3,099	—	31,305	37,079	5,774	—	44,678	42,884
57. Finsbury - -	1,624,296	1,997,600	373,304	—	1,291,274	1,706,400	415,126	—	2,032,567	1,921,472
58. Frome - - -	25,597	22,307	—	3,290	18,448	18,202	—	246	23,001	22,007
59. Gateshead - -	73,556	118,954	45,398	—	57,749	84,590	26,841	—	90,537	89,773

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. — See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
60. GLOUCESTER - -	73,262	75,203	1,941	—	56,316	55,713	—	603	73,454	69,645
61. GRANTHAM - -	40,389	51,249	10,860	—	31,636	42,256	10,620	—	44,684	42,228
62. GREENWICH - -	393,091	498,694	105,603	—	320,282	406,170	85,888	—	527,471	438,094
63. GRIMSBY, GREAT -	41,951	60,375	18,424	—	35,438	54,448	19,010	—	70,542	54,793
64. GUILDFORD - -	23,776	35,926	12,150	—	19,939	28,916	8,977	—	37,249	34,171
65. HALIFAX - -	108,996	143,456	34,460	—	82,763	116,059	33,296	—	148,894	131,227
66. HARWICH - -	12,616	17,625	5,009	—	10,228	14,284	4,056	—	17,809	16,505
67. HASTINGS - - -	106,197	182,595	76,398	—	86,165	146,524	60,359	—	175,194	178,379
68. HELSTON - -	16,918	22,372	5,454	—	15,060	19,118	4,058	—	24,162	22,004
69. HEREFORD - -	54,183	76,487	22,304	—	43,854	62,446	18,592	—	73,186	71,234
70. HERTFORD - -	24,286	33,527	9,241	—	18,212	23,172	4,960	—	27,445	26,593
71. HONITON - - -	13,442	12,847	—	595	9,719	9,965	246	—	13,626	12,129
72. HORSHAM - -	25,135	32,097	6,962	—	19,004	26,281	7,277	—	30,414	30,243
73. HUDDERSFIELD - -	120,041	171,795	51,754	—	95,362	133,011	37,649	—	173,359	156,724
74 HUNTINGDON - -	24,225	34,764	10,539	—	21,241	30,692	9,451	—	32,402	32,369
75. HYTHE - - -	63,387	91,006	27,619	—	54,586	74,708	20,122	—	91,783	81,945

1. NAME OF CITY OR BOROUGH.	2. Gross Estimated Rental at Lady Day, 1856. See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11 Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
76. IPSWICH - - -	112,381	143,946	31,565	—	87,803	125,597	37,794	—	132,869	133,211
77. IVES, ST. - - -	22,512	26,412	3,900	—	18,923	22,146	3,223	—	24,693	25,132
78. KENDAL - - -	33,721	42,886	9,165	—	29,340	36,441	7,101	—	35,627	36,313
79. KIDDERMINSTER - -	41,394	46,519	5,125	—	38,991	37,226	—	1,765	47,197	44,254
80. KINGS LYNN - -	56,733	56,556	—	177	39,826	40,594	768	—	58,560	53,963
81. KINGSTON-UPON-HULL -	291,533	401,934	110,401	—	225,361	307,153	81,792	—	376,262	343,345
82. KNARESBOROUGH -	12,766	13,831	1,065	—	9,548	10,562	1,014	—	14,087	13,676
83. LAMBETH - - -	1,060,410	1,360,708	300,298	—	854,781	1,023,871	169,090	—	1,438,161	1,307,635
84. LANCASTER - -	50,435	56,285	5,850	—	44,289	48,154	3,865	—	55,880	51,854
85. LAUNCESTON - -	23,714	27,688	3,974	—	19,726	23,747	4,021	—	28,998	27,298
86. LEEDS - - -	548,198	743,067	194,869	—	457,792	585,483	127,691	—	765,196	718,010
87. LEICESTER - -	174,181	263,424	89,243	—	130,142	201,056	70,914	—	236,312	244,866
88. LEOMINSTER - -	26,895	38,692	11,797	—	22,714	28,423	5,709	—	32,592	30,852
89. LEWES - - -	34,612	38,373	3,761	—	29,667	32,020	2,353	—	40,189	36,175
90. LICHFIELD - -	27,700	29,872	2,172	—	24,117	25,023	906	—	28,442	28,330
91. LINCOLN - - -	63,273	87,854	24,581	—	52,637	70,883	18,246	—	86,826	83,767

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. — See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
92. LISKEARD - -	18,584	26,866	8,282	—	14,796	23,279	8,483	—	26,556	25,388
93. LIVERPOOL - -	1,680,824	2,655,888	975,064	—	1,527,831	2,402,584	874,753	—	2,248,277	2,235,748
94. LONDON - - -	1,193,412	2,863,633	1,170,221	—	986,472	1,920,582	934,110	—	2,030,438	2,303,664
95. LUDLOW - -	21,557	19,121	—	2,436	16,840	14,118	—	2,722	19,532	17,811
96. LYME REGIS - -	13,221	14,680	1,459	—	10,198	12,584	2,386	—	15,168	14,028
97. LYMINGTON - -	20,565	22,873	2,308	—	16,818	18,957	2,139	—	24,505	22,254
98. MACCLESFIELD - -	86,851	88,583	1,732	—	78,442	75,210	—	3,232	85,022	84,372
99. MAIDSTONE - -	95,390	97,532	2,142	—	79,349	85,711	6,362	—	104,740	94,303
100. MALDON - - -	20,350	25,348	4,998	—	16,480	21,466	4,986	—	25,651	24,910
101. MALMESBURY - -	36,269	40,748	4,474	—	32,451	36,034	3,583	—	42,343	40,716
102. MALTON - -	30,041	29,843	—	198	24,770	25,610	840	—	30,365	26,931
103. MANCHESTER - -	1,427,600	1,676,785	249,185	—	1,189,086	1,398,607	209,521	—	1,589,726	1,578,643
104. MARLBOROUGH - -	16,449	19,109	2,660	—	13,578	16,132	2,554	—	19,469	18,800
105. MARLOW, GREAT -	27,195	32,646	5,451	—	23,081	27,852	4,771	—	37,190	32,345
106. MARYLEBONE - -	2,442,611	3,093,030	650,419	—	2,160,417	2,634,503	474,086	—	3,136,063	2,955,562
107. MIDHURST - -	29,936	33,728	3,792	—	23,189	28,235	5,046	—	34,485	33,423
108. MONMOUTH - -	129,059	139,702	10,643	—	96,632	106,431	9,799	—	113,267	108,925

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. — See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
109. MORPETH - -	34,533	50,767	16,234	—	31,365	46,990	15,625	—	34,205	33,541
110. NEWARK - - -	32,739	46,526	13,787	—	25,733	39,836	14,103	—	39,916	42,310
111. NEWCASTLE-UNDER-LYME	25,667	34,204	8,537	—	24,226	28,255	4,029	—	35,129	33,044
112. NEWCASTLE-UPON-TYNE -	301,368	400,337	98,969	—	254,744	334,467	79,723	—	376,442	373,847
113. NEWPORT (ISLE OF WIGHT)	27,738	33,395	5,657	—	23,761	26,567	2,806	—	33,868	32,577
114. NORTHALLERTON -	23,135	34,801	11,666	—	20,468	29,901	9,433	—	27,775	27,839
115. NORTHAMPTON - -	70,236	117,217	46,981	—	57,163	96,893	39,730	—	117,525	113,205
116. NORWICH - -	199,469	237,913	38,444	—	143,023	171,413	28,390	—	230,358	226,294
117. NOTTINGHAM - -	205,322	292,488	87,166	—	181,649	257,275	75,626	—	280,023	279,813
118. OLDHAM - -	192,594	450,407	257,813	—	179,818	245,868	66,050	—	309,250	325,369
119. OXFORD - - -	143,942	131,110	—	12,832	115,730	100,607	—	15,123	127,498	125,823
120. PENRYN AND FALMOUTH	30,934	41,349	10,415	—	24,438	32,259	7,821	—	42,537	39,596
121. PETERBOROUGH - -	37,940	59,667	21,727	—	32,288	52,158	19,870	—	53,974	50,316
122. PETERSFIELD - -	32,963	39,683	6,720	—	24,079	31,919	7,840	—	37,787	34,371
123. PLYMOUTH - -	178,281	173,530	—	4,751	115,980	144,188	28,208	—	175,120	167,801

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
124. Poole - - -	32,207	28,693	—	3,514	21,526	23,191	1,665	—	27,900	27,727
125. Pontefract - -	39,626	42,729	3,103	—	35,494	35,275	—	219	41,043	33,629
126. Portsmouth - -	195,001	301,372	106,371	—	170,395	257,515	87,120	—	284,068	291,932
127. Preston - - -	211,600	244,056	32,456	—	194,235	204,751	10,516	—	231,445	231,629
128. Reading - -	84,424	112,704	28,280	—	63,358	92,686	29,328	—	109,418	104,934
129. Reigate - - -	47,501	79,093	31,592	—	36,660	64,745	28,085	—	58,265	61,337
130. Retford, East -	280,305	348,458	68,153	—	233,495	322,759	89,264	—	354,559	323,299
131. Richmond - -	19,690	25,474	5,784	—	16,122	22,032	5,910	—	25,917	24,449
132. Ripon - - -	22,861	23,988	1,127	—	20,791	21,795	1,004	—	22,568	22,768
133. Rochdale - -	110,096	141,244	31,148	—	97,747	114,490	16,743	—	132,328	133,230
134. Rochester - -	46,497	63,774	17,277	—	36,571	52,718	16,147	—	59,551	59,936
135. Rye - - -	46,606	52,332	5,726	—	39,850	45,438	5,588	—	60,791	51,327
136. Salford - -	348,841	401,707	52,866	—	309,276	351,353	42,077	—	377,391	351,460
137. Salisbury - -	39,183	43,551	4,368	—	30,845	32,976	2,131	—	42,120	42,329
138. Sandwich - -	38,776	47,703	8,927	—	28,312	37,782	9,470	—	50,656	46,429
139. Scarborough -	59,081	109,104	50.023	—	47,836	88,196	40,360	—	105,163	104,112

1 Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
140. Shaftesbury - -	43,148	49,508	6,360	—	37,300	44,700	7,400	—	51,827	48,904
141. Sheffield - -	478,334	702,579	224,245	—	356,473	529,030	172,557	—	664,043	638,628
142. Shoreham, New -	153,737	189,984	36,247	—	123,544	158,489	34,945	—	209,750	181,920
143. Shrewsbury - -	80,332	91,865	11,533	—	76,973	87,549	10,576	—	90,242	85,585
144. Southampton - -	187,153	218,821	31,668	—	128,728	169,462	40,734	—	202,880	200,566
145. South Shields -	76,793	110,368	33,575	—	57,411	83,961	26,550	—	88,037	75,655
146. Southwark - -	676,947	909,560	232,613	—	536,290	702,834	166,544	—	801,588	740,476
147. Stafford - -	26,211	34,980	8,769	—	23,583	29,143	5,560	—	35,169	33,867
148. Stamford - -	23,985	28,249	4,264	—	21,053	24,125	3,072	—	28,817	26,357
149. Stoke-upon-Trent -	216,226	293,832	77,606	—	182,147	259,607	77,460	—	300,024	246,008
150. Stockport - -	144,558	160,279	15,721	—	111,562	134,153	22,591	—	153,169	148,568
151. Stroud - -	119,560	142,671	23,111	—	99,312	118,549	19,237	—	140,194	136,501
152. Sunderland - -	209,117	288,517	79,400	—	163,841	240,211	76,370	—	260,492	247,941
153. Tamworth - -	37,179	48,613	11,434	—	35,601	42,028	6,427	—	48,037	41,116
154. Taunton - -	51,478	54,442	2,964	—	36,252	45,708	9,456	—	53,514	52,487
155. Tavistock - -	31,271	44,203	12,932	—	29,311	40,950	11,639	—	35,082	30,251
156. Tewkesbury - -	22,019	22,852	833	—	16,669	19,136	2,467	—	22,716	21,691
157. Thetford - -	12,907	13,245	338	—	10,205	10,703	498	—	14,700	12,395

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. — See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
158. THIRSK - -	33,565	34,419	854	—	27,847	30,539	2,692	—	30,818	30,232
159. TIVERTON - -	54,444	45,469	—	8,975	36,536	37,708	1,172	—	46,023	44,382
160. TOTNES - -	15,583	15,890	307	—	12,179	12,665	486	—	16,710	15,658
161. TOWER HAMLETS -	2,231,273	2,769,217	537,944	—	1,597,795	2,152,293	554,498	—	2,390,314	2,301,615
162. TRURO - - -	29,888	35,301	5,413	—	20,949	27,191	6,242	—	35,213	34,665
163. TYNEMOUTH - -	77,628	105,848	28,220	—	62,827	86,748	23,921	—	85,965	82,287
164. WAKEFIELD - -	69,476	85,149	15,673	—	58,602	71,245	12,643	—	71,597	75,845
165. WALLINGFORD -	48,562	54,065	5,503	—	40,472	45,082	4,610	—	45,540	45,833
166. WALSALL - -	92,652	116,787	24,135	—	72,238	88,695	16,457	—	101,028	100,146
167. WAREHAM - -	27,102	27,862	760	—	20,673	23,479	2,806	—	26,391	27,211
168. WARRINGTON - -	65,909	86,741	20,832	—	59,101	72,940	13,839	—	81,186	77,647
169. WARWICK - -	47,290	48,411	1,121	—	36,537	41,423	4,886	—	49,785	46,022
170. WELLS - - -	13,599	14,964	1,365	—	11,619	12,936	1,317	—	15,194	14,612
171. WENLOCK - -	79,821	85,997	6,176	—	71,391	80,180	8,789	—	84,236	76,336
172. WESTBURY -	29,576	31,789	2,213	—	22,964	27,902	4,938	—	32,903	30,602
173. WESTMINSTER - -	2,197,838	2,558,716	360,878	—	1,907,836	2,245,645	337,809	—	2,858,306	2,501,352
174. WEYMOUTH - -	35,826	46,718	10,892	—	26,690	37,351	10,661	—	52,099	45,070

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
	£	£	£	£	£	£	£	£	£	£
175. Whitby	31,053	49,409	18,356	—	27,883	39,957	12,074	—	47,447	47,456
176. Whitehaven	45,602	54,003	8,401	—	39,072	44,920	5,848	—	47,244	47,439
177. Wigan	77,762	95,555	17,793	—	65,882	78,048	12,166	—	85,370	80,864
178. Wilton	58,248	61,686	3,438	—	46,263	54,531	8,268	—	60,520	60,201
179. Winchester	50,203	63,401	13,198	—	42,042	51,067	9,025	—	56,974	59,376
180. Windsor	35,651	44,708	9,057	—	29,108	33,356	4,248	—	47,392	42,763
181. Wolverhampton	360,790	458,618	97,828	—	298,409	368,741	70,332	—	378,770	351,064
182. Woodstock	33,802	46,573	12,771	—	29,281	39,368	10,087	—	44,402	42,623
183. Worcester	90,450	126,898	36,448	—	76,412	105,933	29,521		121,657	121,259
184. Wycombe	21,882	30,473	8,591	—	18,960	24,709	5,749	—	31,534	29,548
185. Yarmouth	88,701	109,191	20,490	—	61,833	71,769	9,936	—	108,562	106,303
186. York	136,547	172,847	36,300	—	112,117	148,717	36,600	—	161,958	162,756
Total of Metropolitan Boroughs	11,426,787	15,052,464	3,625,677	—	9,334,865	12,386,128	3,051,263	—	14,687,437	14,031,776
Total of ENGLAND (exclusive of Metropolitan Boroughs)	19,035,556	24,729,976	*5,436,911	41,735	15,710,739	20,506,196	*4,551,550	25,644	23,532,789	22,427,637
Total ENGLAND	30,462,343	39,782,440	*9,062,588	41,735	25,045,604	32,892,324	*7,602,813	25,644	38,220,226	36,459,413

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* These totals are exclusive of Birkenhead, which was not a Parliamentary Borough in 1856, and consequently was not included in the return of 1860.

1. Name of City or Borough.	2. Gross Estimated Rental at Lady Day, 1856. — See Parliamentary Return, 124, 1860.	3. Present Gross Estimated Rental according to Valuation List or Poor Rate.	4. Increase.	5. Decrease.	6. Rateable Value at Lady Day, 1856.	7. Present Rateable Value according to Valuation List or Poor Rate.	8. Increase.	9. Decrease.	10. Gross Estimated Value according to the Income Tax Assessment, Schedule A., omitting Railways and other Properties assessed upon Profits.	11. Gross Estimated Rental according to Valuation Lists, omitting Properties omitted in Column 10.
WALES.	£	£	£	£	£	£	£	£	£	£
187. Beaumaris	24,772	30,606	5,834	—	19,263	26,526	7,263	—	34,239	29,961
188. Brecon	18,775	22,379	3,604	—	14,006	18,053	4,047	—	21,261	20,708
189. Cardiff	102,593	188,417	85,824	—	79,692	155,261	75,569	—	150,338	133,027
190. Cardigan	28,070	30,786	2,716	—	24,000	28,999	4,999	—	34,468	30,297
191. Carmarthen	58,405	67,902	9,497	—	40,773	57,139	16,366	—	59,063	57,309
192. Carnarvon	50,388	57,798	7,410	—	39,712	45,685	5,973	—	62,253	55,893
193. Denbigh	60,595	64,188	3,593	—	48,687	44,643	—	4,044	63,631	62,765
194. Flint	55,058	59,532	4,474	—	45,202	50,225	5,023	—	52,362	52,425
195. Haverfordwest	26,343	27,153	810	—	20,522	20,962	440	—	28,167	26,552
196. Merthyr Tydfil	180,585	371,742	191,157	—	157,360	288,250	130,890	—	175,096	132,501
197. Montgomery	64,910	67,074	2,164	—	50,188	62,195	12,007	—	66,924	63,198
198. Pembroke	46,495	67,960	21,465	—	34,266	58,824	24,558	—	60,908	59,773
199. Radnor	30,781	36,605	5,824	—	26,147	35 446	9,299	—	40,014	36,269
200. Swansea	105,482	193,743	88,261	—	91,634	158,370	66,736	—	149,767	155,119
Total **WALES**	853,252	1,285,885	432,633	—	691,452	1,050,578	363,170	4,044	998,491	915,797
Total **ENGLAND and WALES**	31,315,595	41,068,325	*9,495,221	41,735	25,737,056	33,942,902	*7,965,983	29,688	39,218,717	37,875,210

* These totals are exclusive of Birkenhead, which was not a Parliamentary Borough in 1856, and consequently was not included in the Return of 1860.

BOROUGH SUMMARY.

1. ABINGDON.

Population in 1831 -	5,259	Population in 1861 -	5,680	Increase -	421
		Population in 1866 (computed) -	5,548	Increase -	289

Inhabited Houses in 1861 - - 1,189

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	—	309	309	—
Scot and Lot Voters - -	300	20	—	280
Total - -	300	329	309	280
			Net Increase. 29	

Double entries on Register of 1865–6:—

As £10 Occupiers - -	5	25	Number who voted at the last General Election.
As £10 Occupiers and Scot and Lot Voters - - -	20		
Actual Number of Electors - -		304	235

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - - - 59

Number of Burgesses - - - - - - - - - -	383
Number of Burgesses whose Rates are assessed on or compounded for by the Owner. -	91
Number of Burgesses on the Parliamentary Register (including double entries) - -	309

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - - -	14,119
The present Gross Estimated Rental is - - - - - -	17,028
Increase - - - - -	2,909

The Rateable Value—	£	
In 1856 was - - -	11,300	Increase since 1856 £1,587
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	11,255	since 1862 £1,632
The present Rateable Value is - - -	12,887	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	18,340
The Gross Estimated Rental of the same description of Property according to the Valuation List is	16,668

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	283
£6 and under £7 - - - - -	153
£7 and under £8 - - -	92
£8 and under £9 - - -	26
£9 and under £10 - - - - -	55
£10 and over - - - -	361
	*970

At a Rateable Value of—	
£4 and under £5 is - - -	141
£5 and under £6 - - - -	134
£6 - - - - - -	1
Above £6 and under £7 - - - -	—
£7 and under £8 - - -	2
£8 and under £9 - - -	118
£9 and under £10 - - -	23
£10 and over - - - -	253

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental, and 15 per cent. on account of Rates when paid by the Landlord, in estimating the Rateable Value of Houses at and under £10. A Rateable Value of £8 is stated to represent a Gross Rental of £10.

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* This total is inserted for the purpose of comparing the number of Male Occupations with the number of Inhabited Houses in the Borough in 1861.

2. ANDOVER.

Population in 1831	4,966	Population in 1861	5,430	Increase	464
		Population in 1866 (computed)	5,448	Increase	482

Inhabited Houses in 1861 - - 1,102

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	229	260	31	—
Freemen	17	3	—	14
Total	246	263	31	14

Net Increase. 17

Double entries on Register of 1865–6 :—

As £10 Occupiers	5	8
As £10 Occupiers and Freemen	3	
Actual Number of Electors		255

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - - 15*

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	22,467
The present Gross Estimated Rental is	27,096
Increase	4,629

The Rateable Value—	£	
In 1856 was	18,509	Increase since 1856 £4,618
In 1862 immediately before the date of the Union Assessment Committee Act it was	19,249	since 1862 £3,878
The present Rateable Value is	23,127	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	27,876
The Gross Estimated Rental of the same description of Property according to the Valuation List is	26,259

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	552
£6 and under £7	48
£7 and under £8	23
£8 and under £9	29
£9 and under £10	11
£10 and over	272
	935

At a Rateable Value of—	
£4 and under £5 is	50
£5 and under £6	35
£6	3
Above £6 and under £7	34
£7 and under £8	15
£8 and under £9	21
£9 and under £10	17
£10 and over	224

The Gross Estimated Rental it is stated is presumed to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6, and 25 per cent. in the case of Houses at less than £6.

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* It is stated that Andover is in an agricultural district, and that therefore comparatively few artizans are employed in the borough, which will account for so few of the Working Classes being on the Register.

3. ARUNDEL.

Population in 1831	- 2,803	Population in 1861	- 2,498	Decrease	305
		Population in 1866 (computed)	- 2,382	Decrease	421

Inhabited Houses in 1861 - - 528

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	—	143	143	—
Scot and Lot Voters	351	31	—	320
Total	351	174	143	320
			Net Decrease. 177	

Actual Number of Electors (No Double entries on Register.)	174	No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	36
As Scot and Lot Voters	16
Total	52

Number of Burgesses	337
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	None.
Number of Burgesses on the Parliamentary Register	157

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—	£	**The Rateable Value**—	£	
In 1856 was	10,318	In 1856 was	7,881	Increase since 1856
The present Gross Estimated Rental is	10,964	The present Rateable Value is	7,988	£107
Increase	646			

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	11,383
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	10,964

The Number of Male Occupiers:—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	193	£4 and under £5 is	96
£6 and under £7	41	£5 and under £6	27
£7 and under £8	17	£6	8
£8 and under £9	11	Above £6 and under £7	16
£9 and under £10	17	£7 and under £8	16
£10 and over	134*	£8 and under £9	19
		£9 and under £10	7
	413	£10 and over	113

The Gross Estimated Rental appears to be from 5 to 10 per cent. less than the full rack rent.

A deduction of from 20 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses which are dilapidated or in bad situations at and under £10, and of from 15 to 20 per cent. in the case of other Houses.

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* In explanation of the Electors on the Register as £10 Occupiers being in excess of the Male Occupiers at £10 Estimated Rental, it is stated that there are some very old houses in the borough which are rated at £9 although the Rental is believed to be £10.

4. ASHBURTON.

Population in 1831 -	4,165	Population in 1861 -	3,062	Decrease -	1,103
		Population in 1866 (computed) -	2,892	Decrease -	1,273

Inhabited Houses in 1861 - - 574

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	146	353*	207	—
Ancient Right Qualifications -	52	3	—	49
Total - -	198	356	207	49
			Net Increase. 158	

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	4	6	No Contest at the last General Election.
As £10 Occupiers and Ancient Right Qualifications -	2		
Actual Number of Electors - -		350	

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - 45

The Gross Estimated Rental—	£
In 1856 was - - - -	13,469
The present Gross Estimated Rental is - - - - -	13,027
Decrease - - -	442

The Rateable Value—	£	
In 1856 was - - -	9,819	Increase since 1856 £959
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	9,380	since 1862 £1,398
The present Rateable Value is - - -	10,778	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	14,044
The Gross Estimated Rental of the same description of Property according to the Valuation List is	12,822

The Number of Male Occupiers:—†

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is - - - - -	266	£4 and under £5 is - -	55
£6 and under £7 - - -	42	£5 and under £6 - - -	63
£7 and under £8 - - - -	56	£6 - - - - - - -	5
£8 and under £9 - - - -	82	Above £6 and under £7 - -	54
£9 and under £10 - - - -	65	£7 and under £8 - -	97
£10 and over - - -	245*	£8 and under £9 - - - -	42
		£9 and under £10 - -	38
	756	£10 and over - - -	147

The Gross Estimated Rental is stated to represent generally the full rack rent.

A deduction of 30 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6. In the case of Houses at £4 and not exceeding £6 the deduction is one third of rental, and in the case of Houses under £4 the deduction is one half of rental.

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* With reference to the excess of £10 Occupiers on the Register over the number of Male Occupiers at a Gross Estimated Rental of £10, it is stated that "many of the Electors of Ashburton are in companies, and are not rated at £10 each; in "other cases Owners are not rated at £10, although they swear the property is worth £10; and in other cases where the Rent "is £10 the Gross Rateable Value is much below that sum."

† When the Owners are assessed in lieu of the Occupiers, and the names of the Occupiers do not appear in the Rate Book, the number of tenements is given.

5. ASHTON-UNDER-LYNE.

Population in 1831 - 14,035	Population in 1861	-	33,917	Increase -	19,882
	Population in 1866 (computed)	-	36,190	Increase -	22,155

Inhabited Houses in 1861 - - 6,460

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	433	967	534
Actual Number of Electors - - (No Double entries on Register.)		967	No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - - 188

Number of Burgesses - - - - - - - - - - 2,574

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 1,816

Number of Burgesses on the Parliamentary Register - - - - - 764

The Parliamentary and Municipal Boundaries are not conterminous, but nearly so. The number of Burgesses without the Parliamentary Borough is 42.

The Small Tenements Act has been adopted. The number of Burgesses prior to its adoption was 1,790.

The Gross Estimated Rental—	£
In 1856 was - - - -	81,975
The present Gross Estimated Rental is - - - - - -	105,590
Increase - - -	23,615

The Rateable Value—	£	
In 1856 was - - -	65,789	Increase since 1856 £17,682
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	75,345	since 1862 £8,126
The present Rateable Value is - - -	83,471	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	109,305
The Gross Estimated Rental of the same description of Property according to the Valuation List is	97,141*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	3,083
£6 and under £7 - - -	560
£7 and under £8 - - -	329
£8 and under £9 - - - -	158
£9 and under £10 - - -	74
£10 and over - - - -	878†
	5,082

At a Rateable Value of—	
£4 and under £5 is - - - -	1,015
£5 and under £6 - - -	1,503
£6 - - - - - -	23
Above £6 and under £7 - - -	311
£7 and under £8 - - -	189
£8 and under £9 -	101
£9 and under £10 - -	83
£10 and over - - -	864

The Gross Estimated Rental is stated to represent the full annual value.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £10, and of 20 per cent. in the case of Houses under £10.

It is almost a universal rule for owners to pay all rates between a Rateable Value of over £6 and £7 16*s*. A deduction of 25 per cent. is made from the rent actually paid to cover the rates, so that a Weekly Rental of 4*s*. would represent a Gross Estimated Rental of £7 16*s*. or a Rateable Value of £6 2*s*.

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* It is stated that cotton mills within the borough are assessed to the property tax at something like 25 per cent. more than their present value to let. In the case of mills not working at all, the assessment to the Poor Rate has been reduced in accordance with a recent decision of the Court of Queen's Bench. There are also one or two instances of large mills from which the fixtures, including engines and machinery, have been removed, and the premises are not rateable in consequence.

† In explanation of the number of Male Occupiers at £10 and over, Gross Estimated Rental, being less than the number of Electors, it is stated that there is a large number of houses in the borough at a fixed weekly rental of what considered sufficient, after deducting the Rates, to leave a net annual sum of £10, but which are only valued in the Valuation List at from £9 to £10, sums quite as much as the property is worth to let. It is believed that there are a great many on the L. who really do not pay £10 a year clear of all rates and taxes.

6. AYLESBURY.

Population in 1831 - 23,434	Population in 1861	- 27,090	Increase	-	3,656
	Population in 1866 (computed)	- 27,239	Increase	-	3,805

Inhabited Houses in 1861 - - 5,718

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Decrease.
£10 Occupiers - -	1,378	1,226	152
Scot and Lot Voters - -	276	103	173
Total - - -	1,654	1,329	325

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	43	104
As £10 Occupiers and Scot and Lot Voters - - -	61	
Actual Number of Electors - - -		1,225

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - -	163
As Scot and Lot Voters - -	22
Total - - -	185
Double entry - -	1
Net number - -	184

A Local Act (9 Vict. c. 3.) is in force in the Parish of Aylesbury with Walton, for rating owners when the yearly rent or value shall not amount to £10.

The Small Tenements Act appears to have been adopted in 22 of the 27 parishes.

The Gross Estimated Rental—	£
In 1856 was - - -	103,178
The present Gross Estimated Rental is - - - -	135,363
Increase - - -	32,185

The Rateable Value—	£	
In 1856 was - -	91,226	Increase since 1856 £31,961
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	98,227	since 1862 £24,960
The present Rateable Value is - - -	123,187	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	142,624
The Gross Estimated Rental of the same description of Property according to the Valuation List is	133,582*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - -	3,430
£6 and under £7 - - -	202
£7 and under £8 - - - -	118
£8 and under £9 - - -	94
£9 and under £10 - - -	116
£10 and over - - -	1,300
	5,260

At a Rateable Value of—	
£4 and under £5 is - - -	354
£5 and under £6 - - -	177
£6 - - -	25
Above £6 and under £7 - -	127
£7 and under £8 - - -	102
£8 and under £9 - - -	155
£9 and under £10 - - -	111
£10 and over - - - -	1,154

In 15 parishes the Gross Estimated Rental it is stated represents the full rack rent. In 12 parishes it is stated to be the fair annual value according to the Assessment Committee Acts and 6 & 7 W. 4. c. 96.

In 13 parishes a deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of new cottages at and under £10, of 20 per cent. for those in fair repair, and of 25 per cent. for thatched or dilapidated cottages. In 12 parishes the deduction varies according to the nature of the property; but in no case is it less than 10 or higher than 25 per cent., and in two parishes a deduction of 20 per cent is made.

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* With reference to the parishes in the Aylesbury Union, it is stated that the assessment on Woodlands is not included in this amount. Also that the Income Tax Assessors receive from the occupiers a return of the actual rent paid, which in many cases may exceed the Gross Estimated Rental fixed by the Assessment Committee who take the rent as the criterion of value when it is known to them, but are not entirely guided by it, if, from the circumstances of any particular case, in their opinion the property is let too high, or, on the contrary, would reasonably be expected to let from year to year for more than the rent. The Valuation Lists in some of the parishes were made two or three years ago.

7. BANBURY.

Population in 1831	6,411	Population in 1861	10,216	Increase	3,805
		Population in 1866 (computed)	11,061	Increase	4,650

Inhabited Houses in 1861 - - 2,068

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	326	763	437	—
Freemen	13	—	—	13
Total	339	763	437	13
			Net Increase. 424	

		Number who voted at the last General Election.
Double entries on Register of 1865–6	149	
Actual Number of Electors	614	531

Number of Working Classes on the present Parliamentary Register - - 125*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	39,486
The present Gross Estimated Rental is	49,423
Increase	9,937

The Rateable Value—	£	
In 1856 was	31,083	Increase since 1856 £9,267
In 1862 immediately before the date of the Union Assessment Committee Act it was	32,772	since 1862 £7,578
The present Rateable Value is	40,350	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	49,906
The Gross Estimated Rental of the same description of Property according to the Valuation List is	46,680

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	589
£6 and under £7	303
£7 and under £8	122
£8 and under £9	107
£9 and under £10	27
£10 and over	779
	1,927

At a Rateable Value of—	
£4 and under £5 is	258
£5 and under £6	311
£6	39
Above £6 and under £7	69
£7 and under £6	53
£8 and under £9	114
£9 and under £10	42
£10 and over	647

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses from £6 to £10, and of 25 per cent. in the case of Houses under £6.

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* It is stated that there are two or three foundries in Banbury and several breweries in which persons who possess the franchise are employed. Also that journeymen in various trades have placed themselves in a position to claim a vote.

8. BARNSTAPLE.

Population in 1831 -	9,272	Population in 1861 -	10,743	Increase -	1,471
		Population in 1866 (computed) -	10,442	Increase -	1,170

Inhabited Houses in 1861 - - 2,186

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	—	581	581	—
Freemen - - -	261	182	—	79
Scot and Lot Voters - -	459	—	—	459
Total -	720	763	581	538
			Net Increase. 43	

Double entries on Register of 1865–6 :— As £10 Occupiers and Freemen - -	48	Number who voted at the last General Election.
Actual Number of Electors - -	715	634

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	49
As Freemen - - - -	77
Total - - - -	126
Double entries - - -	2
Net Number - - - -	124

Number of Burgesses - - - - - - - - -	1,158
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	377
Number of Burgesses on the Parliamentary Register - - - - -	571*

The Small Tenements Act has been adopted in two of the three Parishes.

The Gross Estimated Rental—	£
In 1856 was - - - -	35,253
The present Gross Estimated Rental is - - - - -	33,087
Decrease - - -	2,166

The Rateable Value—	£	
In 1856 was - - -	24,841	Increase since 1856 £531
In 1862 immediately before the date of the Union Assessment Committee Act it was - - -	23,513	since 1862 £1,859
The present Rateable Value is - - - -	25,372	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	33,994
The Gross Estimated Rental of the same description of Property according to the Valuation Lists is	31,821

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	907
£6 and under £7 - - -	106
£7 and under £8 - - -	84
£8 and under £9 - - -	61
£9 and under £10 - - -	40
£10 and over - - - -	689
	1,887

At a Rateable Value of—	
£4 and under £5 is - - -	126
£5 and under £6 - - - -	88
£6 - - - - -	60
Above £6 and under £7 - -	39
£7 and under £8 - - -	86
£8 and under £9 - - - -	39
£9 and under £10 - - -	44
£10 and over - - - -	512

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction not exceeding one third of the rent is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £6 and under, and in the case of Houses above £6 a deduction not exceeding 25 per cent. according to the condition of the premises.

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* The reasons why a larger number of the Parliamentary Electors are not on the Burgess Lists are stated to be (1) the difference between the two franchises (the Municipal Franchise requiring that the voter should be an inhabitant householder, and that he should have occupied and been rated for two years and eight months; and (2) that more than 50 of the Freemen are not occupiers in the borough, and that others are not householders.

9. BATH.

Population in 1831	50,800	Population in 1861	52,528	Increase	1,728
		Population in 1866 (computed)	51,692	Increase	892

Inhabited Houses in 1861 - - 8,017

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.
£10 Occupiers	Qualifications not specified.	3,235	383
Ancient Right Qualification		1	
Total	2,853	3,236	383

Double entries on Register of 1865-6:—

As £10 Occupiers	275	276
As £10 Occupier and Ancient Right Qualification	1	
Actual Number of Electors		2,960

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - - 448

Number of Burgesses - - - - - - - - - 3,488

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 25

Number of Burgesses on the Parliamentary Register - - - - - 2,498

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	273,482
The present Gross Estimated Rental is	280,476
Increase	6,994

The Rateable Value—	£	
In 1856 was	232,733	Increase since 1856 £7,265
In 1862 immediately before the Date of the Union Assessment Committee Act it was	232,222	since 1862 £7,776
The present Rateable Value is	239,998	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	270,284
The Gross Estimated Rental of the same description of Property according to the Valuation List is	266,040

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	465
£6 and under £7	295
£7 and under £8	431
£8 and under £9	226
£9 and under £10	171
£10 and over	4,268*
	5,856

At a Rateable Value of—	
£4 and under £5 is	322
£5 and under £6	206
£6	85
Above £6 and under £7	306
£7 and under £8	178
£8 and under £9	425
£9 and under £10	76
£10 and over	3,887

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 10 to 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6 and under £10, and of from 20 to 25 per cent. in the case of Houses at £6 or under, except when under composition.

Where the Owners are rated, the proportion of rent estimated to cover the rates is about one-sixth (say 3*s.* 4*d.* to 3*s.* 6*d.* in the pound).

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* With reference to the excess of Male Occupiers at £10 Gross Estimated Rental over the number on the Register as £10 Occupiers, it is stated that from 450 to 500 had not been long enough in possession to be on the Register, and 150 or [illegible] were disqualified through nonpayment of rates; and also that Overseers in some parishes improperly enter in the Lists as Occupiers persons who are mere agents, paying rates and letting the houses furnished to season visitors.

10. BEDFORD.

Population in 1831	6,959	Population in 1861	13,413	Increase	6,454
		Population in 1866 (computed)	14,366	Increase	7,407

Inhabited Houses in 1861 - - 2,752

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	930	88	—
Ancient Right Qualifications, Inhabitant Householders, &c.	975	133		
Freemen	597	45	—	552
Total	1,572	1,108	88	552
			Net Decrease. 464	

(The £10 Occupiers are not distinguished in the Return of 1833.)

Double entries on Register of 1865–6:—

As £10 Occupiers and Freemen or Ancient Right Qualifications	2	Number who voted at the last General Election.
Actual Number of Electors	1,106	955

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	221
As Freeman	1
As Voters in respect of Ancient Rights	60
Total	282

Number of Burgesses	1,703
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	410
Number of Burgesses on the Parliamentary Register	918

The Small Tenements Act has been partially adopted.

The Gross Estimated Rental—	£
In 1856 was	40,383
The present Gross Estimated Rental is	58,397
Increase	18,014

The Rateable Value—	£	
In 1856 was	35,948	Increase since 1856 £11,785
In 1862 immediately before the date of the Union Assessment Committee Act it was	42,407	since 1862 £5,326
The present Rateable Value is	47,733	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	54,283
The Gross Estimated Rental of the same description of Property according to the Valuation Lists is	55,844

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	631
£6 and under £7	336
£7 and under £8	178
£8 and under £9	94
£9 and under £10	55
£10 and over	1,188
	2,482

At a Rateable Value of—	
£4 and under £5 is	416
£5 and under £6	267
£6	30
Above £6 and under £7	101
£7 and under £8	53
£8 and under £9	337
£9 and under £10	99
£10 and over	791

The Gross Estimated Rental is stated to represent the full rack rent.

In four parishes a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and in one parish the deduction is from 20 to 25 per cent. A clear Yearly Value of £7 10*s*. appears to represent a Rateable Value of £6.

11. BERWICK-ON-TWEED.

Population in 1831 - 13,129	Population in 1861	-	13,265	Increase -	136
	Population in 1866 (computed)	-	12,435	Decrease -	694

Inhabited Houses in 1861 - - 1,883

Number of Electors on Parliamentary Register :—

	1832–3.		1865–6.	Increase.	Decrease.
£10 Occupiers, or Scot and Lot Voters - - -	269	£10 Occupiers	440	171	—
Freemen - - -	436		376	—	60
Total - -	705		816	171	60
				Net Increase. 111	

Double entries on Register of 1865–6 :—				
As £10 Occupiers - -	3		85	Number who voted at the last General Election.
As £10 Occupiers and Freemen	82			
Actual Number of Electors	-		731	675

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - -	96
As Freemen - - - -	221
Total - - -	317
Deduct Double entries -	11
Net Number - - -	306

Number of Burgesses - - - - - - - - -	825
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	198
Number of Burgesses on the Parliamentary Register - - - - - -	582

The Small Tenements Act has been partially adopted.

The Gross Estimated Rental—	£
In 1856 was - - -	44,996
The present Gross Estimated Rental is - - - - -	47,825
Increase - - - -	2,829

The Rateable Value—	£	
In 1856 was - - -	41,265	Decrease since 1856 £201
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	40,751	
The present Rateable Value is - - - -	41,064	Increase since 1862 £313

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	38,941
The Gross Estimated Rental of the same description of Property according to the Valuation List is	38,236

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	2,179
£6 and under £7 - - - - -	88
£7 and under £8 - - -	22
£8 and under £9 - - -	24
£9 and under £10 - - -	14
£10 and over - - -	508
	2,835

At a Rateable Value of—*	
£4 and under £5 is - - -	22
£5 and under £6 - - -	38
£6 - - - - -	12
Above £6 and under £7 - -	16
£7 and under £8 - - -	30
£8 and under £9 - - - -	18
£9 and under £10 - - -	67
£10 and over - - -	452

The Gross Estimated Rental is stated to represent the full rack rent.

The deductions made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 are as follows: Houses in good condition, 5 per cent.; medium, 10 per cent.; bad, 15 per cent.

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* It appears that in addition to the number of Male Occupiers included in the Return, there are assessments upon Owners under the Small Tenements Act, as follows :—at £4 and under £5, 65 ; at £5 and under £6, 51 ; at £6, 19 ; above £6 and under £7, 14 ; at £7 and under £8, 29 ; at £9 and under £10, 19 ; and at £10 and over, 65. These assessments are on groups of tenements, each assessment representing one or two houses, let off in tenements, mostly consisting of one room only, the whole being occupied by from 15 to 20 or even 30 different families. In the cases in which the Owners compound, the Rateable Value is entered in the Valuation List at less than one-half of the Gross Rental. The full Rateable Value of the tenements could not be estimated without first ascertaining the rent actually paid in each case.

12. BEVERLEY.

Population in 1831	8,263	Population in 1861	10,868	Increase	2,605
		Population in 1866 (computed)	11,297	Increase	3,034

Inhabited Houses in 1861 - - - 2,403

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	146	619	473	—
Freemen	865	855	—	10
Total	1,011	1,474	473	10

Net Increase.
463

Double entries on Register of 1865–6 :—

As £10 Occupiers	27	235	Number who voted at the last General Election.
As £10 Occupiers and Freemen	208		
Actual Number of Electors		1,239	1,108

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	196
As Freemen	589
	785
Deduct Double entries	123
Net Number	662

The Parliamentary and Municipal Boundaries are not conterminous.

The Gross Estimated Rental—	£
In 1856 was	44,857
The present Gross Estimated Rental is	50,180
Increase	5,323

The Rateable Value—	£	
In 1856 was	41,731	Increase since 1856 £1,622
In 1862 immediately before the date of the Union Assessment Committee Act it was	42,696	since 1862 £657
The present Rateable Value is	43,353	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	46,860
The Gross Estimated Rental of the same description of Property according to the Valuation List is	45,974

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	1,058
£6 and under £7	111
£7 and under £8	91
£8 and under £9	77
£9 and under £10	40
£10 and over	638
	2,015

At a Rateable Value of—	
£4 and under £5 is	421
£5 and under £6	141
£6	42
Above £6 and under £7	42
£7 and under £8	74
£8 and under £9	79
£9 and under £10	63
£10 and over	517

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £6 and upwards, and of 20 per cent. in the case of Houses under £6.

13. BEWDLEY.

Population in 1831 - 7,939	Population in 1861	-	7,084	Decrease -	855
	Population in 1866 (computed)	-	6,970	Decrease -	969

Inhabited Houses in 1861 - - 1,598

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	312	356	44	—
Burgesses - -	25	5	—	20
Total - -	337	361	44	20
			Net Increase. 24	

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	1	5
As £10 Occupiers and Burgesses	4	
Actual Number of Electors - -		356

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 35

The Parliamentary and Municipal Boundaries are not conterminous.

Three of the four Parishes are each under a Local Act, authorizing the rating of Owners instead of Occupiers, the limit of Rateable Value in such cases being £7.

The Gross Estimated Rental—	£
In 1856 was - - -	26,195
The present Gross Estimated Rental is - - - - -	26,438
Increase - - -	243

The Rateable Value—	£	
In 1856 was - -	21,417	Increase since 1856 £1,630
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	20,777	since 1862 £2,270
The present Rateable Value is - - -	23,047	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	24,251
The Gross Estimated Rental of the same description of Property according to the Poor Rate is -	25,758

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	863
£6 and under £7 - - -	84
£7 and under £8 - - -	37
£8 and under £9 - - -	80
£9 and under £10 - - -	22
£10 and over - - -	546*
	1,632

At a Rateable Value of—	
£4 and under £5 is - - -	100
£5 and under £6 - -	35
£6 - - - -	1
Above £6 and under £7 - -	70
£7 and under £8 - - -	33
£8 and under £9 - - -	64
£9 and under £10 - -	43
£10 and over - - - -	412

The Gross Estimated Rental is stated as a rule to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and above £8, and of 25 per cent. in the case of Houses under £8.

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* With reference to the excess of Occupiers at £10 Gross Estimated Rental over £10 Occupiers on the Register, it is stated that doubtless there are many qualified to be on the Register who are not on, and that there is an apathy in the matter, a contested election not having taken place for many years.

14. BIRKENHEAD.

Population in 1831 - 4,195	Population in 1861	- 51,649	Increase	- 47,454
	Population in 1866 (computed)	- 60,604	Increase	- 56,409

Inhabited Houses in 1861 - - 7,189

Number of Electors on Parliamentary Register :—

	1865–6.	Number who voted at the last General Election.
£10 Occupiers - - -	4,563	
Actual Number of Electors - (No Double entries on Register.)	4,563	3,181

Number of Working Classes on the present Parliamentary Register - 2,065*

The Small Tenements Act has been adopted.

The present Gross Estimated Rental	£	**The Rateable Value—**	£	
is - - - - - -	299,244	In 1862 immediately before the date of the Union Assessment Committee Act was - - -	217,233	Increase since 1862 £52,318
		The present Rateable Value is - -	269,551	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	270,667
The Gross Estimated Rental of the same description of Property according to the Valuation List or Poor Rate is - - - - - - - - - - -	264,573

The Number of Male Occupiers :—‡

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is - - - - -	534	£4 and under £5 is - - - -	315
£6 and under £7 - - - - -	166	£5 and under £6 - - - - -	270
£7 and under £8 - - - -	452	£6 - - - - - - -	371
£8 and under £9 - - - - -	545	Above £6 and under £7 - - -	145
£9 and under £10 - - - -	344	£7 and under £8 - - -	491
£10 and over - - - -	6,829†	£8 and under £9 - - - - -	322
		£9 and under £10 - - - -	708
	8,870	£10 and over - - - -	6,213

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 10 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* In Birkenhead there are no works of any consequence in which men are employed in manufacture, except highly skilled and well-paid artificers with wages from 40*s.* to 60*s.* per week. Rents are stated to be exceptionally high, involving the necessity of operatives unskilled and labourers occupying houses in common of a rent sufficiently high to give a vote to one, whereas if rents were lower each family would be occupying a house under £10.

† With reference to the excess of Male Occupiers at £10 Gross Estimated Rental over the £10 Occupiers on the Register, it is stated that it is accounted for by the disqualification of police officers, letter carriers, excise officers, paupers, and persons excused payment of rates on the ground of poverty, and those not on the Rate Book for twelve months. Persons are constantly removing between Birkenhead and Liverpool on account of convenience as regards employment. Mariners also who are not at home at the revision of the List by the revising barrister are generally struck off in consequence of an objection being taken against them by their opponents in politics.

‡ The Dock Cottages in Birkenhead are let out in flats, but the occupiers of the flats are separately assessed.

15. BIRMINGHAM.

Population in 1831	143,986	Population in 1861	296,076	Increase	152,090
		Population in 1866 (computed)	333,868	Increase	189,882

Inhabited Houses in 1861 - - 59,060

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers	4,309	15,497	11,188

Double entries on Register of 1865–6 :—

As £10 Occupiers, about	500	
Estimated Number of Electors	14,997	No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	2,895
Deduct double entries	12
Net number	2,883*

Number of Burgesses	17,840
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	6,446
Number of Burgesses on the Parliamentary Register	11,984

A Local Act (1 & 2 Will. 4. c. 67.) is in force in the Parish of Birmingham with a rating limit not exceeding £12 yearly value, except where Houses are let to weekly or monthly tenants. Another Local Act, 10 & 11 Vict. c. 66, with a rating limit of £7 10*s.* Rateable Value, except where Houses are let in lodgings or separate apartments, is in force in the Parish of Edgbaston; and another Local Act (9 & 10 Vict. c. 225.) embracing tenements assessed at any annual sum not exceeding £7 is in force in part of the Parish of Aston.

The Gross Estimated Rental—	£	**The Rateable Value**—	£	
In 1856 was	988,563	In 1856 was	792,764	Increase since 1856
The present Gross Estimated Rental is	1,189,483	The present Rateable Value is	966,363	£173,599
Increase	200,920			

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	1,171,296
The Gross Estimated Rental of the same description of Property according to the Valuation List is	1,101,3 13

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—‡	
Under £6 is	13,233	£4 and under £5 is	14,049
£6 and under £7	10,369	‡£5 and under £6	10,132
£7 and under £8	7,210	£6	3,170
£8 and under £9	6,367	Above £6 and under £7	3,206
£9 and under £10	1,382	£7 and under £8	3,035
£10 and over	19,062†	£8 and under £9	1,557
		£9 and under £10	1,545
	57,623	£10 and over	15,852

In Birmingham, the Gross Estimated Rental represents the Annual Value, the Landlord paying for Insurance, Repairs, &c. In Edgbaston, the Gross Estimated Rental represents the full rack-rent, except when the Landlords make the local payments, and then 20 per cent. is deducted. In the part of the Parish of Aston within the Borough, it is from 15 to 20 per cent. less than the full rack rent.

In Birmingham a deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10. In Edgbaston the deduction is 20 per cent. In Aston, in the case of compounded houses up to and inclusive of £5 Gross Estimated Rental, the landlord paying tenant's rates, &c., the deduction is 25 per cent., and for houses from £5 to £10, 20 per cent.

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* The return of the Working Classes on the Register in the parish of Birmingham is based on an estimate. There are 3,252 Voters who are the Occupiers of Tenements from £10 to £15 Gross Estimated Rental (the whole of this class being compound property), and of these 795 names were taken and canvassed, and it was found that 50 per cent. are Mechanics, Artizans, &c. Of the 3,017 Voters above £15 Gross Estimated Rental 4¼ per cent. were found to be Mechanics, &c., a canvass being made in the cases in which the Occupations were not known.

† With reference to the excess of Male Occupiers at £10 Gross Estimated Rental over the Electors, it is stated that the discrepancy in the parish of Birmingham arises from the fact that the residence of some of the Occupiers has not been of sufficient duration to enable them to be placed on the Register. It is accounted for in the part of Aston included in the borough by the frequent removal of tenants from houses at rentals of about £10 or £12, very few claims being made by Voters for successive occupations.

‡ With reference to Aston it is stated that the names of the Occupiers of small tenements in respect of which the Owners are rated do not as a rule appear on the Rate Book. About three years ago, however, the name of every Occupier was ascertained, and it was found that the void houses and those occupied by women constituted about one fifth and a half of the total, and the numbers given in the return have been calculated on that proportion of deduction in each class.

16. BLACKBURN.

Population in 1831 -	27,091	Population in 1861 -	63,126	Increase -	36,035
		Population in 1866 (computed) -	78,522	Increase -	46,431

Inhabited Houses in 1861 - - 11,306

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	626	1,894	1,268

		Number who voted at the last General Election.
Actual Number of Electors - - (No Double entries on Register.)	1,894	1,733

Number of Working Classes on the present Parliamentary Register - - 332

Number of Burgesses - - - - -	6,486
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	4,403
Number of Burgesses on the Parliamentary Register - - - -	1,580

The Small Tenements Act is in force.

The Gross Estimated Rental—	£
In 1856 was - - -	126,373
The present Gross Estimated Rental is - - - -	176,451
Increase - - -	50,078

The Rateable Value—	£	
In 1856 was - -	118,476	Increase since 1856 £26,122
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	144,589	since 1862 £ 9
The present Rateable Value is - - -	144,598	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	201,355
The Gross Estimated Rental of the same description of Property according to the Valuation List is	165,713

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	5,721
£6 and under £7 - - -	1,937
£7 and under £8 - - -	347
£8 and under £9 - - -	349
£9 and under £10 - - -	437
£10 and over - - - -	1,798
	10,589

At a Rateable Value of—	
£4 and under £5 is - - -	3,026
£5 and under £6 - - -	1,741
£6 - - - - - -	220
Above £6 and under £7 - -	479
£7 and under £8 - - -	372
£8 and under £9 - - -	361
£9 and under £10 - - -	302
£10 and over - - -	1,357

The Gross Estimated Rental computed by the Valuers is stated to be in the aggregate about 18 per cent. less than the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

17. BODMIN.

Population in 1831	- 5,228	Population in 1861	- 6,381	Increase	-	1,153
		Population in 1866 (computed)	- 6,403	Increase	-	1,175

Inhabited Houses in 1861 - - 1,191

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	222	401	179	—
Capital Burgesses - -	30	2	—	28
Total - -	252	403	179	28
			Net Increase, 151	

Double entries on Register of 1865–6 :—			
As £10 Occupiers - - -	4	6	
As £10 Occupiers and Capital Burgesses - - - -	2		Number who voted at the last General Election.
Actual Number of Electors - - -		397	347

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 104

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act does not appear to have been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - - -	22,256
The present Gross Estimated Rental is - - - - -	24,711
Increase - - -	2,455

The Rateable Value—	£	
In 1856 was - - -	17,731	Increase since 1856 £4,049
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	18,317	
The present Rateable Value is - - - - -	21,780	since 1862 £3,463

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	26,938
The Gross Estimated Rental of the same description of Property according to the Valuation List is	24,082

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	525
£6 and under £7 - - - -	49
£7 and under £8 - - - -	26
£8 and under £9 - - - -	20
£9 and under £10 - - - -	9
£10 and over - - - -	377*
	1,006

At a Rateable Value of—	
£4 and under £5 is - - - -	67
£5 and under £6 - - -	32
£6 - - - -	12
Above £6 and under £7 - - -	13
£7 and under £8 - - -	52
£8 and under £9 - - - -	29
£9 and under £10 - - -	20
£10 and over - - - -	286

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 10 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, according to the state of the repair of the buildings.

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* With reference to the number of Male Occupiers at £10 Gross Estimated Rental being less than the number of £10 Occupiers on the Register, it is stated that persons occupying their own tenements having made claims before the Revising Barristers have, in the absence of opposition, been allowed to be placed on the Register, although the real annual value of the properties is less than £10.

18. BOLTON.

Population in 1831 - 42,245	Population in 1861 -	70,395	Increase -	28,150
	Population in 1866 (computed) -	75,516	Increase -	33,271

Inhabited Houses in 1861 - - 13,129

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.
£10 Occupiers - -	1,040	2,293	1,253

		Number who voted at the last General Election.
Double entries on Register of 1865-6 - - - -	107	
Actual Number of Electors - - -	2,186	1,887

Number of Working Classes on the present Parliamentary Register - -	467
Number of Burgesses - - - - - - - - - -	8,092
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	4,769
Number of Burgesses on the Parliamentary Registers - - - -	1,924

The Small Tenements Act is in force in two of the three parishes. The number of Burgesses prior to its adoption was 2,539.

The Gross Estimated Rental—	£
In 1856 was - - -	178,882
The present Gross Estimated Rental is - - -	226,476
Increase - - -	47,594

The Rateable Value—	£	
In 1856 was - -	149,078	Increase since 1856 £35,410
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	172,822	since 1862 £11,666
The present Rateable Value is - - -	184,488	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	240,314
The Gross Estimated Rental of the same description of Property according to the Valuation List or Poor Rate is - - - - - - - - -	213,713*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	5,610
£6 and under £7 - - -	1,896
£7 and under £8 - - -	1,111
£8 and under £9 - - -	619
£9 and under £10 - - -	240
£10 and over - - -	2,737
	12,213

At a Rateable Value of—	
£4 and under £5 is - -	3,074
£5 and under £6 - -	1,727
£6 - - - - -	656
Above £6 and under £7 - -	556
£7 and under £8 - - -	383
£8 and under £9 - - -	638
£9 and under 10 - - -	234
£10 and over - - -	1,941

The Gross Estimated Rental it is stated represents the full rack rent in two of the Townships, and in the third, Little Bolton, it is about 5 per cent. below.

A deduction of 15 per cent. in Tong with Haulgh, and of 20 per cent. in the other two townships, is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* It is stated that a great many cellar dwellings have been recently closed by the borough authorities, and therefore are not in the Rate Book. In Schedule A. the mills and works are returned at considerably more than their Gross Annual Value as ascertained by a recent special valuation. Cottages, the rentals of which are 2*s*. per week, and which are assessed to the Poor Rate at £4 (which is the correct amount after allowance for Rates, &c.), appear in the Income Tax Assessment at £6 and £7, and it is the same with regard to other property.

19. BOSTON.

Population in 1831 -	12,798	Population in 1861 -	17,893	Increase -	5,095
		Population in 1866 (computed) -	18,084	Increase -	5,286

Inhabited Houses in 1861 - - 3,901

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	513	945	432	—
Freemen and Scot and Lot Voters	372	Freemen 148	—	224
Total - - -	885	1,093	432	224
			Net Increase. 208	

Double entries on Register of 1865–6 :—

As £10 Occupiers - - -	29	72	Number who voted at the last General Election.
As £10 Occupiers and Freemen -	43		
Actual Number of Electors - -		1,021	966

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	115
As Freemen - - - - - -	84
	199
Double entries - -	2
Net Number - - -	197

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted in two out of the three Parishes. Prior to its adoption the number of Burgesses was 818. The present number is 1,720.

The Gross Estimated Rental—	£
In 1856 was - - - -	51,076
The present Gross Estimated Rental is - - - - - -	68,560
Increase - - -	17,484

The Rateable Value—	£	
In 1856 was - - - -	46,237	Increase since 1856 £10,163
In 1862 immediately before the date of the Union Assessment Committee Act it was - - -	48,053	since 1862 £8,347
The present Rateable Value is - - - - -	56,400	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	74,866*
The Gross Estimated Rental of the same description of Property according to the Valuation List is	63,923*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	1,426
£6 and under £7 - - -	413
£7 and under £8 - - - -	140
£8 and under £9 - - -	54
£9 and under £10 - - - -	107
£10 and over - - - -	874
	3,014

At a Rateable Value of—	
£4 and under £5 is - - -	635
£5 and under £6 - - - -	339
£6 - - - - - -	50
Above £6 and under £7 - - -	39
£7 and under £8 - - - -	125
£8 and under £9 - - - -	74
£9 and under £10 - - -	80
£10 and over - - - -	755

In one Parish the Gross Estimated Rental is stated to be about 5 per cent. less than the full rack rent, and in two Parishes slightly below it.

On an average a deduction of about 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

A Rateable Value of £6 10*s.* represents yearly rentals of £8 5*s.*, £8 10*s.*, and £8 15*s.*

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* The difference between the two assessments to the extent of £6,000 or £7,000 it is stated is attributable to the fact that in fixing the amount of the Gross Estimated Rental in respect of cottage property of £6 rating and under, of which there is a vast quantity in Boston, an allowance is made from the rack rent for poor and other rates paid by the landlord, whilst the Income Tax Assessment represents the full Gross Rent paid to the landlord without any deduction whatever. In the parish of Skirbeck the land appears to have been rated at sums varying from £2 to £3 per acre, whilst the rents actually paid are £4, £5, and £6, and in some few instances £7, per acre. Interest of monies charged upon places of worship, and which is assessed to the Income Tax, is not assessable to the Poor Rate.

20. BRADFORD.

Population in 1831 -	43,527	Population in 1861 -	106,218	Increase - 62,691
		Population in 1866 (computed) -	107,459	Increase - 63,932

Inhabited Houses in 1861 - - - 22,518

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - -	1,139	5,189	4,050

Actual Number of Electors - - - - (No Double entries on Register.)	5,189	No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - - 438

Number of Burgesses - - - - - - - - - 19,604

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 10,844

Number of Burgesses on the Parliamentary Register - - - - - - 5,189*

The Small Tenements Act is in force in all the Parishes. The total number of Burgesses prior to its adoption was 5,058.

The Gross Estimated Rental—	£
In 1856 was - - - - -	336,508
The present Gross Estimated Rental is - - - - - -	452,450
Increase - - -	115,942

The Rateable Value—	£	
In 1856 was - -	262,610	Increase since 1856 £115,443
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	295,034	since 1862 £83,019
The present Rateable Value is - - -	378,053	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	451,294
The Gross Estimated Rental of the same description of Property according to the Valuation List is	424,026

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	8,708
£6 and under £7 - - - -	4,835
£7 and under £8 - - - -	1,302
£8 and under £9 - - - -	1,447
£9 and under £10 - - - -	334
£10 and over - - - -	6,170
	22,796

At a Rateable Value of—	
£4 and under £5 is - - -	5,093
£5 and under £6 - - -	4,226
£6 - - - - - -	679
Above £6 and under £7 - -	596
£7 and under £8 - - -	1,474
£8 and under £9 - - -	611
£9 and under £10 - - -	435
£10 and over - - - -	5,024

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6, and of 20 per cent. in the case of Houses under £6.

Weekly rentals of 3*s.* 3*d.* to 3*s.* 6*d.* represent a Gross Estimated Rental of £7 1*s.* and a Rateable Value of £6.

It appears that the landlords of all Houses at weekly rentals up to 4*s.* 9*d.* take upon themselves the payment of the rates.

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* It is stated that from the way in which the Burgess Lists are made out the names on the Parliamentary Register are on the Burgess Roll. " The overseers are not mindful to make a Return of those persons only who may have occupied a house, counting-" house, or shop during the necessary period ; but if a person be a ratepayer in respect of property of another description, he is " invariably placed upon the Burgess List, and very rarely are any objections made at the revision."

21. BRIDGNORTH.

Population in 1831 -	6,517	Population in 1861 -	7,699	Increase - 1,182
		Population in 1866 (computed) -	7,744	Increase - 1,227

Inhabited Houses in 1861 - - 1,570

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Decrease.
£10 Occupiers - -	Qualifications not distinguished.	381	88
Freemen - -		277	
Total - -	746	658	88

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	7	44	Number who voted at the last General Election.
As £10 Occupiers and Freemen	37		
Actual Number of Electors - - -		614	534

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - - -	55
As Freemen - - - - - - -	132
Total - - - - - -	187

The Parliamentary and Municipal Boundaries are conterminous.

The Small Tenements Act has been partially adopted.

The Gross Estimated Rental—	£
In 1856 was - - - -	32,363
The present Gross Estimated Rental is - - - -	34,434
Increase - -	2,071

The Rateable Value—	£	
In 1856 was - -	28,271	Increase since 1856 £3,560
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	28,231	since 1862 £3,600
The present Rateable Value is - - -	31,831	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	34,019
The Gross Estimated Rental of the same description of Property according to the Valuation List is	33,641

The Number of Male Occupiers :—

At a Gross Estimated Rental—	
Under £6 is - - - - -	566
£6 and under £7 - - - -	99
£7 and under £8 - - - -	44
£8 and under £9 - - -	47
£9 and under £10 - -	16
£10 and over - - -	410
	1,182

At a Rateable Value of—	
£4 and under £5 is - - -	239
£5 and under £6 - -	136
£6 - - - - - -	—
Above £6 and under £7 - -	51
£7 and under £8 - - -	69
£8 and under £9 - - -	51
£9 and under £10 - - -	40
£10 and over - - -	369

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 12½ per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

22. BRIDGWATER.

Population in 1831	- 7,279	Population in 1861	11,320	Increase	- 4,041
		Population in 1866 (computed)	- 11,857	Increase	- 4,578

Inhabited Houses in 1861 - - - 2,123

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	352	638	286	—
Scot and Lot Voters - -	132	41	—	91
Total - -	484	679	286	91
			Net Increase. 195	
Double entries on Register of 1865–6:— As £10 Occupiers and Scot and Lot Voters -		35	Number who voted at the last General Election.	
Actual Number of Electors - -		644	557	

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - -	281
As Scot and Lot Voters - - - -	9
Total - - - -	290
Deduct Double entries - -	6
Net Number - - -	284*

Number of Burgesses - - - - - - - - -	619
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	None.
Number of Burgesses on the Parliamentary Register - - - - -	546

The Parish of Bridgwater has adopted the Small Tenements Act, but it is not in force in the Parishes of Wembdon and Durleigh.

Until this year the Occupiers of Houses compounded for have been in the Burgess List, and *last year* the total number on the List was 1,768. *This year* the Overseers List comprised only the persons actually rated, and as there were no claims made the List remained as returned, hence the reduced number.

The Gross Estimated Rental—	£
In 1856 was - - - - -	28,747
The present Gross Estimated Rental is - - - - - -	33,075
Increase - - -	4,328

The Rateable Value—	£	
In 1856 was - -	19,638	Increase since 1856
The present Rateable Value is - - -	27,351	£7,713

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	32,392
The Gross Estimated Rental of the same description of Property according to the Valuation List is	31,142

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	729
£6 and under £7 - - -	193
£7 and under £8 - - -	183
£8 and under £9 - - -	185
£9 and under £10 - - -	—
£10 and over - - - -	750
	2,040

At a Rateable Value of—	
£4 and under £5 is - - -	301
£5 and under £6 - - -	243
£6 - - - - -	179
Above £6 and under £7 - -	1
£7 and under £8 - - -	2
£8 and under £9 - - -	237
£9 and under £10 - - -	32
£10 and over - - - -	525

The Gross Estimated Rental it is stated is supposed to represent the full rack rent.

A deduction of from 15 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parish of Bridgwater; of 15 per cent. in the Parish of Durleigh; and of 15 to 20 per cent. in the Parish of Wembdon.

All Houses which are of less value than £10 a year are treated as within the operation of the Small Tenements Act.

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* A large number of the Working Classes on the Register derive their support from working at the foundries, railway carriage works, brick and pottery manufactories, and in connexion with the shipping of Bridgwater.

23. BRIDPORT.

Population in 1831	6,684	Population in 1861	7,719	Increase	1,035
		Population in 1866 (computed)	7,797	Increase	1,113

Inhabited Houses in 1861 - - 1,581

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	111	475	364	—
Scot and Lot Voters	322	28	—	294
Total	433	503	364	294

Net Increase. 70

Double entries on Register of 1865–6:—

As £10 Occupiers	19	31
As £10 Occupiers and Scot and Lot Voters	12	
Actual Number of Electors		472

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	134
As Scot and Lot Voters	11
Total	145
Deduct Double entries	2
Net Number	143

Number of Burgesses	716
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	837
Number of Burgesses on the Parliamentary Register	380

The Small Tenements Act is in operation in a majority of the Parishes.

The Gross Estimated Rental—	£
In 1856 was	19,966
The present Gross Estimated Rental is	21,133
Increase	1,167

The Rateable Value—	£	
In 1856 was	16,218	Increase since 1856 £973
In 1862 immediately before the date of the Union Assessment Committee Act it was	16,591	since 1862 £600
The present Rateable Value is	17,191	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	24,837
The Gross Estimated Rental of the same description of Property according to the Valuation List is	20,823

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	501
£6 and under £7	95
£7 and under £8	82
£8 and under £9	45
£9 and under £10	6
£10 and over	536
	1,265

At a Rateable Value of—	
£4 and under £5 is	233
£5 and under £6	90
£6	51
Above £6 and under £7	42
£7 and under £8	13
£8 and under £9	138
£9 and under £10	47
£10 and over	323

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

24. BRIGHTON.

Population in 1831 -	41,994	Population in 1861 -	87,317	Increase - 45,323
		Population in 1866 (computed) -	97,750	Increase - 55,756

Inhabited Houses in 1861 - - - 13,983

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - -	1,649	6,352	4,703

Double entries on Register of 1865-6 :— As £10 Occupiers - - -	374	Estimated Number who voted at the last General Election.
Actual Number of Electors - - -	5,978	4,990

Number of Working Classes on the present Parliamentary Register - 1,978*

A Local Act (6 Geo. 4. c. 179.) is in force for rating Owners, the limit of rental or value to which the Act applies being £20.

The Gross Estimated Rental—	£
In 1856 was - - - -	455,775
The present Gross Estimated Rental is - - - - - -	541,388
Increase - - -	85,613

The Rateable Value—	£	
In 1856 was - - -	382,259	Increase since 1856
The present Rateable Value is - - -	453,802	£71,543

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	610,015§
The Gross Estimated Rental of the same description of Property according to the Poor Rate or Valuation List is - - - - - - - - - - -	527,919§

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	507
£6 and under £7 - - - - -	497
£7 and under £8 - - - - -	379
£8 and under £9 - - - - -	612
£9 and under £10 - - - - -	572
£10 and over - - - -	†8,627
	11,194

At a Rateable Value of—‡	
£4 and under £5 is - - - - -	244
£5 and under £6 - - - - -	477
£6 - - - - - -	357
Above £6 and under £7 - - - -	65
£7 and under £8 - - - -	843
£8 and under £9 - - - - -	656
£9 and under £10 - - - - -	585
£10 and over - - - -	7,800

The Gross Estimated Rental in Brighton Parish is stated to be computed at 5 per cent. under the full rack rent. In Hove it represents the full rack rent.

In the Parish of Brighton a deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and in the Parish of Hove the deduction is 20 per cent. in the case of Houses above £6, and 25 per cent. under £6.

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* There are nearly 1,500 men employed in the railway workshops, exclusive of engine drivers, stokers, and porters, and upwards of 500 of them are on the Register, and come within the description of artizans, &c. The town, as the resort of many thousands of visitors, employs a very large number of mechanics of all trades, especially tailors, shoemakers, journeymen butchers, bakers, &c. The amount of building that has been going on for 10 years also has found occupation for a vast number of bricklayers, plasterers, masons, carpenters, &c.

† With reference to the excess of Male Occupiers at a Rateable Value of £10 over Electors on Register it is stated that 1,634 are Compound Occupiers, that persons of that class frequently change their place of abode, and that a great many of them never make a claim to be placed on the Register. 420 houses have been recently erected, and have not been occupied sufficiently long to confer a vote.

‡ In Brighton parish the return includes the number of tenements rated to the Owners instead of the Occupiers, after a deduction for Female Occupiers. There are two houses let out in flats. The occupations are as follows :—20 at £3 14*s.* Gross Estimated Rental, 12 at £4 5*s.*, 1 at £12 10, and 2 at £17 10*s.*

§ The difference between the two assessments is accounted for as follows :—The Income Tax Assessment is founded on a return of the actual amount of rent paid by the occupier ; the assessment to the Poor Rate is based on an estimate of the rent. The assessment to the Income Tax is revised at least once in three years, and consequently has the advantage of any increase in value of property that may occur in the interval, whereas the assessment of the great majority of properties to the Poor Rate continues comparatively unchanged, except in cases where the property is palpably improved or rebuilt. It is also well known that in many instances the assessment to the Income Tax is in excess of the actual rent paid, more especially in cases of property let on lease for a term of years.

25. BRISTOL.

Population in 1831 - 104,408 { Population in 1861 - 154,093 Increase - 49,685
Population in 1866 (computed) - 163,228 Increase - 58,820

Inhabited Houses in 1861 - - 23,590

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers and Freeholders - - -	5,006	10,697 1,920	7,611	—
Freemen - - -	5,309	1,707	—	3,602
Total - - -	10,315	14,324	7,611	3,602

Net Increase.
4,009

Double entries on Register of 1865-6 :—

As £10 Occupiers - -	768	* 3,021	Number who voted at the last General Election.
As £10 Occupiers and Freemen, &c.	2,253		
Actual Number of Electors - -		11,303	9,400

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - -	3,440
As Freemen and Freeholders - -	655
Freeholders - - - - -	256
Total - - -	4,351
Deduct Double entries -	300
Net Number - - -	4,051†

Number of Burgesses - - - - - - - - - -	11,631
Number of Burgesses whose Rates are assessed on the Owner or compounded for by him	2,568
Number of Burgesses on the Parliamentary Register - - - - -	8,507

A Local Act, 3 Geo. 4. c. 24. s. 57., appears to be in force in 24 Parishes; the limit for rating the Owner being £20 yearly rent or value, except where Houses are let to weekly or monthly tenants, or in separate apartments. Another Local Act, 2 Will. 4. c. 89., is in force in the united Parishes of St. James and St. Paul, the rating limit being £12, with a similar exception.

The Small Tenements Act has been adopted in 4 Parishes.

The Gross Estimated Rental—	£
In 1856 was - - - -	535,873
The present Gross Estimated Rental is - - - - -	650,123
Increase - - -	114,250

The Rateable Value—	£	
In 1856 was - - -	459,659	Increase since 1856 £93,838
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	500,611	since 1862 £52,886
The present Rateable Value is - - -	553,497	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	625,256
The Gross Estimated Rental of the same description of Property according to the last Poor Rate or Valuation List is - - - - - - - - - -	610,087

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	2,846
£6 and under £7 - - -	1,364
£7 and under £8 - - -	1,477
£8 and under £9 - - -	1,420
£9 and under £10 - - -	1,214
£10 and over - - -	13,962
	22,283

At a Rateable Value of— ‡	
£4 and under £5 is - - -	1,848
£5 and under £6 - - -	1,576
£6 - - - -	1,483
Above £6 and under £7 - -	804
£7 and under £8 - - -	1,028
£8 and under £9 - - -	1,580
£9 and under £10 - - -	1,175
£10 and over - - - -	11,331

The Gross Estimated Rental is stated to represent the full rack rent.

In the City of Bristol a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10. In the Parish of Bedminster the deduction is 20 per cent. in the case of Houses at £8 and under, and 15 per cent. above £8. In the Parishes in the Clifton Union the deduction is 20 per cent. on Houses under £10, and 15 per cent. at £10 and over.

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* These numbers are estimated upon a comparison of the Lists for certain parishes and the Lists of Freemen and Freeholders.

† It is stated that there are very many manufacturing and other trade establishments in Bristol, employing large numbers of men of the Working Class, many of whom are £10 occupiers; also that the political associations are very active in securing the registration of such of their adherents as are qualified.

‡ In the under-mentioned cases in the City of Bristol the names of the Male Occupiers (Rateable Value) do not appear on the rates, and the number of tenements is given,—

At £4 and under £6 - -	1,306	At £8 and under £9 - - -	270
At £6 - - - - -	479	At £9 and under £10 - -	79
At £7 and under £8 - -	276	At £10 and over - - -	[illegible]

There are 70 houses (40 above £6) let out in distinct tenements. A house-to-house visitation would be necessary to ascertain the number and value of the separate occupations.

In the case of compounded tenements the augmentation of the rent to cover the rates is estimated at rather more than 25 per cent.

26. BUCKINGHAM.

Population in 1831	7,418	Population in 1861	7,626	Increase	208
		Population in 1866 (computed)	7,414	Decrease	4

Inhabited Houses in 1861 - - 1,706

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	300	405	105	—
Freemen	12	2	—	10
Total	312	407	105	10

Net Increase. 95

Double Entries on Register of 1865–6 :—

As £10 Occupiers	14	16	Number who voted at the last General Election.
As £10 Occupiers and Freemen	2		
Actual Number of Electors		391	296

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - - - 10*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in the principal part of the Borough.

The Gross Estimated Rental—	£
In 1856 was	35,675
The present Gross Estimated Rental is	45,416
Increase	9,741

The Rateable Value—	£	
In 1856 was	30,536	Increase since 1856 £10,308
In 1862 immediately before the date of the Union Assessment Committee Act it was	32,203	since 1862 £8,641
The present Rateable Value is	40,844	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	47,264
The Gross Estimated Rental of the same description of Property according to the Valuation List is	44,738

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	913
£6 and under £7	60
£7 and under £8	37
£8 and under £9	29
£9 and under £10	14
£10 and over	387†
	1,440

At a Rateable Value of—	
£4 and under £5 is	62
£5 and under £6	53
£6	12
Above £6 and under £7	24
£7 and under £8	8
£8 and under £9	43
£9 and under £10	15
£10 and over	361

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at above £6 and under £10, and of £25 per cent. in the case of Houses at and below £6.

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* Scarcely any kind of manufacture is carried on within the limits of the borough. The district is purely agricultural, and those of the population who may be described as mechanics, artizans, &c. for the most part occupy houses of less value than £10.

† With reference to the excess of Electors on the Register as £10 Occupiers (391) over the number of Male Occupiers at £10 Gross Estimated Rental (387) it is suggested that there may be cases in which a person, who has paid a rate but has not been nominally rated (a Joint Occupier for instance), has been placed on the Register, and that there also may have been cases occasionally in which claims have been admitted when the properties have been rated at less than £10.

27. BURY.

Population in 1831 -	19,140	Population in 1861 -	37,563	Increase -	18,423
		Population in 1866 (computed) -	41,175	Increase -	22,035

Inhabited Houses in 1861 - - 7,257

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	535	1,366	831

		Number who voted at the last General Election.
Double entries on Register of 1865–6 - - - - -	14	
Actual Number of Electors - - -	1,352	1,167

Number of Working Classes on the present Parliamentary Register - 218

The Gross Estimated Rental—	£
In 1856 was - - -	112,884
The present Gross Estimated Rental is - - -	131,595
Increase - - -	18,711

The Rateable Value—	£	
In 1856 was - -	86,014	Increase since 1856 £38,758
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	110,752	since 1862 £14,020
The present Rateable Value is - - -	124,772	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	127,163
The Gross Estimated Rental of the same description of Property according to the Valuation List is	116,537

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	2,561
£6 and under £7 - - -	1,262
£7 and under £8 - - - -	635
£8 and under £9 - - - -	260
£9 and under £10 - - - -	198
£10 and over - - -	1,591
	6,507

At a Rateable Value of—	
£4 and under £5 is - - - -	1,404
£5 and under £6 - - -	1,590
£6 - - - - -	—
Above £6 and under £7 - -	445
£7 and under £8 - - -	229
£8 and under £9 - - -	282
£9 and under £10 - - - -	167
£10 and over - - -	1,228

The Gross Estimated Rental is considered to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

28. BURY ST. EDMUNDS.

Population in 1831	11,436	Population in 1861	13,318	Increase	1,882
		Population in 1866 (computed)	13,036	Increase	1,600

Inhabited Houses in 1861 - - 2,852

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	590	689	99	—
Freemen or Burgesses	30	8	—	22
Total	620	697	99	22
			Net Increase. 77	

Double entries on Register of 1865–6 :—

As £10 Occupiers	16	21	Number who voted at the last General Election.
As £10 Occupiers and Freemen	5		
Actual Number of Electors		676	620

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 90

Number of Burgesses	1,504
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	788
Number of Burgesses on the Parliamentary Register	615

The Small Tenements Act is in force throughout the whole Borough.

The Gross Estimated Rental—	£	**The Rateable Value**—	£	
In 1856 was	49,475	In 1856 was	37,737	Increase since 1856
The present Gross Estimated Rental is	49,915	The present Rateable Value is	41,878	£4,141
Increase	440			

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	50,937
The Gross Estimated Rental of the same description of Property according to the Poor Rate is	48,693

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	825	£4 and under £5 is	386
£6 and under £7	504	£5 and under £6	562
£7 and under £8	39	£6	4
£8 and under £9	103	Above £6 and under £7	106
£9 and under £10	25	£7 and under £8	44
£10 and over	741	£8 and under £9	129
		£9 and under £10	16
	2,237	£10 and over	650

The Gross Estimated Rental is the actual full rack rent after a preliminary deduction of one tenth.

A deduction of one tenth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parish of St. James, and of one sixth in the Parish of St. Mary.

The highest weekly rent is 2*s.* 9*d.*, which is a very general rent for a decent cottage ; beyond that amount Houses are generally let at rentals of even pounds.

29. CALNE.

Population in 1831 -	4,795	Population in 1861 -	5,179	Increase -	384
		Population in 1866 (computed)	5,171	Increase -	376

Inhabited Houses in 1861 - - 1,105

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Decrease.
£10 Occupiers - - -	176	172	4
Ancient Burgesses - - -	15	3	12
Total - -	191	175	16

Double entry on Register of 1865-6 :—

As £10 Occupier and Ancient Burgess - - - - - - 1

Actual Number of Electors - - - 174

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - - - - 7*

The Small Tenements Act has been adopted in the Parish of Calne.

The Gross Estimated Rental—	£
In 1856 was - - - -	24,406
The present Gross Estimated Rental is - - - -	25,219
Increase - - -	813

The Rateable Value—	£	
In 1856 was - - -	21,453	Increase since 1856 £1,132
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	21,911	since 1862 £674
The present Rateable Value is - - -	22,585	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	26,990
The Gross Estimated Rental of the same description of Property according to the Valuation List is	24,863

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - -	624
£6 and under £7 - - -	48
£7 and under £8 - - -	27
£8 and under £9 - - -	17
£9 and under £10 - - -	4
£10 and over - - - -	190
	910

At a Rateable Value of—	
£4 and under £5 is - - -	138
£5 and under £6 - - -	52
£6 - - - - - -	21
Above £6 and under £7 - -	9
£7 and under £8 - - -	12
£8 and under £9 - - -	17
£9 and under £10 - - -	12
£10 and over - - -	165

The Gross Estimated Rental is stated to represent the fair average value of the premises.

A deduction of from 10 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* There are comparatively but few houses in the borough the rents of which are at or near £10 per annum. By far the greater number of mechanics, artizans, &c. whose average wages are from 15*s.* to 25*s.* per week are living in houses at a Rental below £8 per annum, and in some cases below £6.

30. CAMBRIDGE.

Population in 1831 - 20,917	Population in 1861 -	26,361	Increase	-	5,444
	Population in 1866 (computed) -	25,663	Increase	-	4,746

Inhabited Houses in 1861 - - 5,388

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	1,420	1,905	485	—
Freemen - - -	79	21	—	58
Total - -	1,499	1,926	485	58
			Net Increase. 427	

Double Entries on Register of 1865–6 :—			
As £10 Occupiers - -	143	157	Number who voted at the last General Election.
As £10 Occupiers and Freemen -	14		
Actual Number of Electors - - -		1,769	1,497

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	495
As Freemen - - - - -	4
Total - -	499†

Number of Burgesses - - - - - - - - -	2,615
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	588
Number of Burgesses on the Parliamentary Register - - - - -	1,580

There are 14 Parishes in the Borough. The Small Tenements Act has been adopted in almost all of them.

The Gross Estimated Rental—	£
In 1856 was - - -	127,329
The present Gross Estimated Rental is - - - - -	133,558
Increase - - -	6,229

The Rateable Value—	£	
In 1856 was - -	98,579	Increase since 1856 £15,921
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	108,333	since 1862 £6,167
The present Rateable Value is - - -	114,500	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	112,009
The Gross Estimated Rental of the same description of Property according to the Valuation List is	106,337

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	671
£6 and under £7 - - - -	349
£7 and under £8 - - - -	562
£8 and under £9 - - - -	237
£9 and under £10 - - - -	133
£10 and over - - -	1,970
	3,922

At a Rateable Value of—*	
£4 and under £5 is - - -	329
£5 and under £6 - - -	459
£6 - - - - -	493
Above £6 and under £7 - -	334
£7 and under £8 - - -	165
£8 and under £9 - - -	299
£9 and under £10 - - -	112
£10 and over - - -	1,573

The Gross Estimated Rental is stated to represent the full rack rent where the same can be accurately ascertained; and, if not, Schedule A. of Property Tax Assessment.

The following deductions are made from the Gross Estimated Rental or Property Tax Assessment in estimating the Rateable Value of Houses at and under £10 :—First class houses, $12\frac{1}{2}$ per cent.; second class, 15; third class, 20; fourth class, 25; and in exceptional cases $33\frac{1}{3}$ per cent.

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* In 476 cases in which the Owners are assessed the names of the Occupiers do not appear on the Rate Book, and the number of tenements and not of the Male Occupiers is entered in the Return. Of these assessments 98 are on tenements rated at £6, 109 at £5 and under £6, 43 at £4 and under £5, and 226 at under £4.

A large proportion of houses, although let for a sum exceeding £6, are considered to come within the provisions of the Small Tenements Act, and it is at the present time a subject-matter of complaint and investigation by the overseers of St. Andrew-the-Less that houses of the annual value of between £6 and £10 should be permitted to be placed within the provisions of that Act.

† In this number a considerable number of voters described as college servants are included.

31. CANTERBURY.

Population in 1831 - 16,112	Population in 1861 -	21,324	Increase -	5,212
	Population in 1866 (computed) -	22,957	Increase -	6,845

Inhabited Houses in 1861 - - 3,908

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - -	302	1,084	782	—
Freemen - - - -	1,209	724	—	485
Total - -	1,511	1,808	782	485
			Net Increase. 297	

Double entries on Register of 1865–6 :—			Number who voted at the last General Election.
As £10 Occupiers - - -	17	205	
As £10 Occupiers and Freemen -	188		
Actual Number of Electors - -		1,603	1,385

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - -	144
As Freemen - - - - - -	372
Total - - -	516
Deduct Double entry - -	1
Net Number - -	515

Number of Burgesses - - - - - - - - -	1,576
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	467
Number of Burgesses on the Parliamentary Register - - - - -	1,060

A Local Act, 54 Geo. 3. c. 114., is in force in a large portion of the Borough, the limit for rating the Owner being £10 yearly value, net assessment, except in the case of Tenements let for a less period than quarterly, or in separate apartments.

The Small Tenements Act is in force in one of the Parishes.

The Gross Estimated Rental—	£
In 1856 was - - - -	64,630
The present Gross Estimated Rental is	71,452
Increase - -	6,822

The Rateable Value—	£	
In 1856 was - -	51,018	Increase since 1856 £6,038
The present Rateable Value is - - -	57,056	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	79,937
The Gross Estimated Rental of the same description of Property according to the last Poor Rate or Valuation List is - - - - - - - - - - - -	69,494†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - - -	901
£6 and under £7 - - - - -	368
£7 and under £8 - - -	387
£8 and under £9 - - -	418
£9 and under £10 - - -	227
£10 and over - - - - -	1,349
	3,650

At a Rateable Value of—*	
£4 and under £5 is - - -	301
£5 and under £6 - - - -	167
£6 - - - - -	62
Above £6 and under £7 - - -	119
£7 and under £8 - -	87
£8 and under £9 -	179
£9 and under £10 - - -	66
£10 and over - - -	1,047

In 14 Parishes the Gross Estimated Rental is from 5 to 10 per cent. less than the rack rent, and in the other Parishes (with the exception of the extra-parochial places) the Gross Estimated Rental is stated to represent the full rack rent.

In 14 Parishes a deduction of one fifth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 ; but in the case of cottage property compounded for, the deduction is rather more than one half. In 6 Parishes the deduction is from 20 to 25 per cent., and in 6 from 15 to 25 per cent.

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* There being no Poor Rate in the five small extra-parochial places in the City, the returns for these places are based on the Borough Rate. If the several compounded properties in the City were entered in the Rate Book at their full Rateable Value the number of Male Occupiers would be as follows :—At £4 and under £5, 655 ; at £5 and under £6, 460 ; at £6, 351 ; at £6 and under £7, 128 ; at £7 and under £8, 263 ; at £8 and under £9, 190 ; at £9 and under £10, 83 ; at £10 and over, 1,066.

† It is stated that in the Canterbury Incorporation, a farm, the actual rental of which is £1,050, is rated at £750. With regard to the parishes in the Bridge Union, partly within and partly without the City, it is stated that the Clerk to the Guardians has been unable to obtain any accurate information as to the lands comprised within the city boundaries.

32. CARLISLE.

Population in 1831	18,865	Population in 1861	29,417	Increase	10,552
		Population in 1866 (computed)	31,106	Increase	12,241

Inhabited Houses in 1861 - - 5,140

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	1,196	1,196	—
Freemen	406	310	—	96
Scot and Lot Voters	571	—	—	571
Total	977	1,506	1,196	667
			Net Increase. 529	

Double entries on Register of 1865–6 :—

As £10 Occupiers	144	202	Number who voted at the last General Election.
As £10 Occupiers and Freemen	58		
Actual Number of Electors		1,304	1,195

Number of Working Classes on the present Parliamentary Register :—

£10 Occupiers	148
Freemen	167
Total	315
Deduct Double entries	6
Net Number	309

Number of Burgesses	3,377
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	2,450
Number of Burgesses on the Parliamentary Register	1,035

The Small Tenements Act is in force in all the Parishes except Eaglesfield Abbey, but in that Parish there are only 40 inhabitants according to the Census of 1861.

The Gross Estimated Rental—	£
In 1856 was	75,226
The present Gross Estimated Rental is	82,206
Increase	6,980

The Rateable Value—	£	
In 1856 was	59,433	Increase since 1856
The present Rateable Value is	70,106	£10,673

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	93,610
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	73,369*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	3,066
£6 and under £7	440
£7 and under £8	232
£8 and under £9	161
£9 and under £10	78
£10 and over	947
	4,924

At a Rateable Value of—	
£4 and under £5 is	597
£5 and under £6	272
At £6	96
Above £6 and under £7	153
£7 and under £8	108
£8 and under £9	123
£9 and under £10	77
£10 and over	892

The Gross Estimated Rental is stated to be about 15 per cent. less than the full rack rent.†

With the exception of the Parish of Caldewgald, in which 25 per cent. is deducted, a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The difference between the two assessments is accounted for by a great portion of the property being now let for much higher sums than those entered in the present Poor Rate Valuation. It is stated that the amount according to the Union Assessment Valuation, when completed, will probably be about the same as the Income Tax Assessment, Schedule A.

† Where the landlord pays all rates, and for water, 15 per cent. is taken off in estimating the Gross Rental. For instance, A pays 3*s*. 6*d*. a week or £9 2*s*. per annum clear of rates; deduct 15 per cent., which leaves £7 14*s*. 9*d*. Gross Estimated Rental and £6 3*s*. 9*d*. Rateable Value.

33. CHATHAM.

Population in 1831	21,124	Population in 1861	36,177	Increase - 15,053
		Population in 1866 (computed)	40,814	Increase - 19,690

Inhabited Houses in 1861 - - - 5,185

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	677	2,111	1,434
Double entries on Register of 1865–6 - - -		7	
			Number who voted at the last General Election.
Actual Number of Electors - - -		2,104	1,691

Number of Working Classes on the present Parliamentary Register - 970*

The Gross Estimated Rental—	£
In 1856 was - - - - -	53,279
The present Gross Estimated Rental is - - - - -	79,152
Increase - - -	25,873

The Rateable Value—	£	
In 1856 was - - -	44,034	Increase since 1856 £25,541
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	52,397	
The present Rateable Value is - - - -	69,575	since 1862 £17,178

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	80,356
The Gross Estimated Rental of the same description of Property according to the Valuation List is	76,824

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	759
£6 and under £7 - - - - -	650
£7 and under £8 - - - -	733
£8 and under £9 - - -	398
£9 and under £10 - - - -	202
£10 and over - - - -	2,817
	5,559

At a Rateable Value of—†	
£4 and under £5 is - - - -	839
£5 and under £6 - - -	428
£6 - - - - - -	370
Above £6 and under £7 - -	444
£7 and under £8 - - -	227
£8 and under £9 - - - -	1,164
£9 and under £10 - - -	296
£10 and over - - - -	1,261

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The several Government establishments, the Dockyards in particular, it is stated fully account for a large number of the working classes being on the Register.

† The Occupiers of tenements in this borough, the Owners of which are assessed, do not appear on the Valuation Lists for Assessments of £6 and under.

34. CHELTENHAM.

Population in 1831	22,942	Population in 1861	39,693	Increase	16,751
		Population in 1866 (computed)	42,240	Increase	19,298

Inhabited Houses in 1861 - - 7,012

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	919	2,793	1,874

		Number who voted at the last General Election.
Actual Number of Electors (No double entries on Register.)	2,793	2,286

Number of Working Classes on the present Parliamentary Register - 984*

The Gross Estimated Rental—	£
In 1856 was	190,000
The present Gross Estimated Rental is	230,939
Increase	40,939

The Rateable Value—	£	
In 1856 was	164,900	Increase since 1856 £31,208
In 1862 immediately before the date of the Union Assessment Committee Act it was	174,370	since 1862 £21,738
The present Rateable Value is	196,108	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	224,688
The Gross Estimated-Rental of the same description of Property according to the Valuation Lists is	224,520

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	589
£6 and under £7	365
£7 and under £8	357
£8 and under £9	495
£9 and under £10	189
£10 and over	3,495†
	5,490

At a Rateable Value of—	
£4 and under £5 is	716
£5 and under £6	357
£6	—
Above £6 and under £7	484
£7 and under £8	196
£8 and under £9	532
£9 and under £10	186
£10 and over	2,678

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses under £10.

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* There is a large Railway Carriage and Waggon Manufactory in Cheltenham, employing a great number of artizans.

† With reference to the excess of Male Occupiers at £10 Gross Estimated Rental over Electors it is stated that the List of Electors as made out by the Overseers numbered 3,162, which was reduced at the revision to 2,793.

35. CHESTER.

Population in 1831	21,344	Population in 1861	31,110	Increase	9,766
		Population in 1866 (computed)	32,930	Increase	11,586

Inhabited Houses in 1861 - - - 5,971

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	1,598	1,598	—
Freemen	1,379	1,102	—	277
Scot and Lot Voters	649	—	—	649
Total	2,028	2,700	1,598	926
			Net Increase. 672	

Double entries on Register of 1865–6 :—

As £10 Occupiers	170	426	Number who voted at the last General Election.
As £10 Occupiers and Freemen	256		
Actual Number of Electors		2,274	2,146

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	361
As Freemen	653
Total	1,014
Deduct Double entries	27
Net Number	987

Number of Burgesses - - - - - - - - - - - 3.893

Number of Burgesses whose Rates are assessed on or compounded for by the Owner 2,312

Number of Burgesses on the Parliamentary Register - - - - - 1,423

There are 14 Parishes. The Small Tenements Act is in force in almost all of them.

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was	80,688	In 1856 was	63,824	Increase since 1856 £30,172
The present Gross Estimated Rental is	114,127	In 1862 immediately before the date of the Union Assessment Committee Act it was	83,301	
Increase	33,439	The present Rateable Value is	93,996	since 1862 £10,695

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	103,979
The Gross Estimated Rental of the same description of Property according to the Poor Rate or Valuation List is	102,890

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	1,887	£4 and under £5 is	933
£6 and under £7	1,037	£5 and under £6	1,079
£7 and under £8	326	£6	298
£8 and under £9	131	Above £6 and under £7	138
£9 and under £10	81	£7 and under £8	110
£10 and over	1,612	£8 and under £9	183
		£9 and under £10	27
	5,074	£10 and over	1,404

The Gross Estimated Rental is stated to represent the full rack rent.

In the City of Chester a deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and in the Parishes of Boughton-cum-Spital and Great Boughton a deduction of 15 per cent.

36. CHICHESTER.

Population in 1831 - 7,356	Population in 1861	-	8,059	Increase	- 703
	Population in 1866 (computed)	-	7,773	Increase	- 417

Inhabited Houses in 1861 - - 1,601

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers - -	503	559	56	—
Freemen - - - -	64	2	—	62
Scot and Lot Voters - -	285	26	—	259
Total -	852	587	56	321

Net Decrease.
265

Double entries on Register of 1865-6 :—

As £10 Occupiers - -	15	25
As £10 Occupiers and Freemen or Scot and Lot Voters - -	10	
Actual Number of Electors - -		562

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - -	143
As Scot and Lot Voters - - -	13
Total - - -	156
Deduct Double entry -	1
Net Number - -	155

Number of Burgesses - - - - - - - - - -	748
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	198
Number of Burgesses on the Parliamentary Register - - - - - -	390

There are 13 Parishes. The Small Tenements Act is in force in 7 of them.

The Gross Estimated Rental—	£
In 1856 was - - - -	29,126
The present Gross Estimated Rental is - - - - - -	30,042
Increase - - -	916

The Rateable Value—	£	
In 1856 was - -	24,265	Decrease since 1856
The present Rateable Value is - - -	24,187	£78

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	36,699
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	29,426

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	361
£6 and under £7 - - -	235
£7 and under £8 - - -	57
£8 and under £9 - - -	123
£9 and under £10 - - -	29
£10 and over - - - -	548
	1,353

At a Rateable Value of—	
£4 and under £5 is - - -	162
£5 and under £6 - - -	24
£6 - - - - - -	6
Above £6 and under £7 - -	52
£7 and under £8 - - -	134
£8 and under £9 - - -	65
£9 and under £10 - - -	4
£10 and over - - - -	527

The Gross Estimated Rental it is stated in the Parishes of Rumboldswhyke, Newtown, and St. James represents the full rack rent. In the remaining 15 Parishes it is 15 per cent. less.

With the exceptions of the Parish of Rumboldswhyke, in which 25 per cent. is deducted, and the Parish of St James, in which 20 per cent. is deducted, a deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses over £8, and a "further deduction" on Houses under £8.

37. CHIPPENHAM.

Population in 1831 - 5,270	Population in 1861	-	7,075	Increase -	1,805
	Population in 1866 (computed)	-	7,508	Increase -	2,238

Inhabited Houses in 1861 - - 1,345

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers - -	112	402	290	—
Freemen - - -	96	5	—	91
Total - -	208	407	290	91
			Net Increase. 199	

Double entries on Register of 1865-6 :—

As £10 Occupiers - -	10	15	Number who voted at the last General Election.
As £10 Occupiers and Freemen	5		
Actual Number of Electors - -		392	362

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - 73

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act appears to have been adopted in two of the four Parishes.

The Gross Estimated Rental—	£
In 1856 was - - - - -	39,418
The present Gross Estimated Rental is - - - - - -	41,034
Increase - - -	1,616

The Rateable Value—	£	
In 1856 was - -	26,926	Increase since 1856 £6,845
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	28,258	since 1862 £5,513
The present Rateable Value is - - -	33,771	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	35,557
The Gross Estimated Rental of the same description of Property according to the Valuation List is	35,652

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	486
£6 and under £7 - -	116
£7 and under £8 - - -	68
£8 and under £9 - - -	50
£9 and under £10 - - -	27
£10 and over - - - -	465
	1,212

At a Rateable Value of—	
£4 and under £5 is - -	178
£5 and under £6 - - -	62
£6 - - - - - -	22
Above £6 and under £7 - - -	36
£7 and under £8 - - -	96
£8 and under £9 - - - -	17
£9 and under £10 - - -	37
£10 and over - - - -	299

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 30 per cent. on Property within that portion of the Borough named in the Chippenham Improvement Act, and 25 per cent. on the remainder, is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10

38. CHRISTCHURCH.

Population in 1831 -	6,077	Population in 1861 -	9,368	Increase -	3,291
		Population in 1866 (computed) -	10,487	Increase -	4,410

Inhabited Houses in 1861 - - 1,832

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers - -	193	419	226	—
Burgesses - -	13	—	—	13
Total - - -	206	419	226	13
			Net Increase. 213	

		Number who voted at the last General Election.
Actual Number of Electors - - - - (No Double entries on Register.)	419	354

Number of Working Classes on the present Parliamentary Register - - 77

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - -	44,755
The present Gross Estimated Rental is	58,911
Increase - - - - -	14,156

The Rateable Value—	£	
In 1856 was - -	34,431	Increase since 1856 £15,267
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	37,296	since 1862 £12,402
The present Rateable Vulue is - - -	49,698	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	58,438
The Gross Estimated Rental of the same description of Property according to the Valuation List, or last Poor Rate, is - - - - - - - - - - -	58,645

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	335
£6 and under £7 - - -	114
£7 and under £8 - - -	51
£8 and under £9 - - -	34
£9 and under £10 - - -	30
£10 and over - - - -	517
	1,081

At a Rateable Value of—	
£4 and under £5 is - - -	184
£5 and under £6 - - -	111
£6 - - - - - -	15
Above £6 and under £7 - -	35
£7 and under £8 - - -	29
£8 and under £9 - - -	41
£9 and under £10 - - -	24
£10 and over - - - -	429

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6 and under £10, and 25 per cent. for Houses at £6 and less.

39. CIRENCESTER.

Population in 1831	5,420	Population in 1861	6,336	Increase	916
		Population in 1866 (computed)	6,460	Increase	1,040

Inhabited Houses n 1861 - - - 1,300

Number of Electors on Parliamentary Register:—

	1832-3.		1865-6.	Decrease.
Inhabitant Householders legally settled	604	£10 Occupiers	416	140
		Ancient rights	48	
	604		464	140

		Number who voted at the last General Election.
Actual Number of Electors (No Double entries on Register.)	464	403

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	77
Ancient right qualifications	42
Total	119

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	20,276
The present Gross Estimated Rental is	29,179
Increase	8,903

The Rateable Value—	£	
In 1856 was	17,297	Increase since 1856 £7,017
In 1862 immediately before the date of the Union Assessment Committee Act it was	20,903	
The present Rateable Value is	24,314	since 1862 £3,411

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	28,897
The Gross Estimated Rental of the same description of Property according to the Valuation List is	28,679

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	443
£6 and under £7	108
£7 and under £8	60
£8 and under £9	37
£9 and under £10	11
£10 and over	436
	1,095

At a Rateable Value of—	
£4 and under £5 is	200
£5 and under £6	87
£6	28
Above £6 and under £7	48
£7 and under £8	39
£8 and under £9	96
£9 and under £10	39
£10 and over	383

The Gross Estimated Rental it is stated is supposed to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

40. CLITHEROE.

Population in 1831 - 9,890	Population in 1861	-	10,864	Increase -	974
	Population in 1866 (computed)	-	10,569	Increase -	679

Inhabited Houses in 1861 - - 2,247

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - - -	288	484	196	—
Freemen - - - - - -	18	—	—	18
Total - - - -	306	484	196	18
			Net Increase. 178	

Double entries on Register of 1865–6:—

As £10 Occupiers - - - - -	46
Actual Number of Electors - -	438

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - - 64

The Parliamentary and Municipal Boundaries are not conterminous.

Neither the Small Tenements Act, nor any Local Act authorizing the rating of Owners instead of Occupiers, is in force.

The Gross Estimated Rental—	£
In 1856 was - - - -	34,578
The present Gross Estimated Rental is - - - - - -	45,327
Increase - - - - -	10,749

The Rateable Value—	£	
In 1856 was - -	29,612	Increase since 1856 £9,046
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	32,536	
The present Rateable Value is - - -	38,658	since 1862 £6,122

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	46,162
The Gross Estimated Rental of the same description of Property according to the Valuation Lists is	43,605

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	1,078
£6 and under £7 - - - -	176
£7 and under £8 - - -	119
£8 and under £9 - - - -	32
£9 and under £10 - - - -	32
£10 and over - - - - -	540
	1,977

At a Rateable Value of—	
£4 and under £5 is - - - -	429
£5 and under £6 - -	158
£6 - - - - - - -	9
Above £6 and under £7 - -	115
£7 and under £8 - - -	44
£8 and under £9 - - - - -	89
£9 and under £10 - - - -	31
£10 and over - - - - -	430

The Gross Estimated Rental it is stated is supposed to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £6 and under, and 15 per cent. for Houses above £6.

41. COCKERMOUTH.

Population in 1831 -	6,022	Population in 1861 -	7,057	Increase -	1,035
		Population in 1866 (computed) -	6,950	Increase -	928

Inhabited Houses in 1861 - - 1,543

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	305	356	51
Double entries on Register of 1865–6 - - -		20	No contest at the last General Election.
Actual Number of Electors - - -		336	

Number of Working Classes on the present Parliamentary Register -	35
Double entry - - -	1
Net Number - - - -	34

The Small Tenements Act has been partially adopted.

The Gross Estimated Rental—	£
In 1856 was - - -	25,299
The present Gross Estimated Rental is - - - -	29,953
Increase - - -	4,654

The Rateable Value—	£	
In 1856 was - -	21,274	Increase since 1856 £4,795
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	22,209	since 1862 £3,860
The present Rateable Value is - - -	26,069	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	28,854
The Gross Estimated Rental of the same description of Property according to the Valuation List is	28,116

The Number of Male Occupiers*:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	992
£6 and under £7 - - - - -	82
£7 and under £8 - - - -	29
£8 and under £9 - - -	46
£9 and under £10 - - -	14
£10 and over - - - -	408
	1,571

At a Rateable Value of—	
£4 and under £5 is - - -	184
£5 and under £6 - - -	65
£6 - - - - - - -	—
Above £6 and under £7 - -	24
£7 and under £8 - - -	19
£8 and under £9 - - - -	48
£9 and under £10 - - -	26
£10 and over - - - -	343

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6, and 20 per cent. in the case of Houses at £6 and under.

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* The Valuation List for Cockermouth parish does not give the names of Occupiers of small tenements, and in those cases the number of tenements and not of Male Occupiers is given.

42. COLCHESTER.

Population in 1831 - 16,167	Population in 1861 -	23,809	Increase -	7,642
	Population in 1866 (computed) -	26,347	Increase -	10,180

Inhabited Houses in 1861 - - 4,447

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	1,019	1,019	—
Freemen	476	405	—	71
Scot and Lot Voters	623	—	—	623
Total	1,099	1,424	1,019	694

Net Increase.
325

Double entries on Register of 1865–6:—

			Number who voted at the last General Election.
As £10 Occupiers	12	19	
As £10 Occupiers and Freemen	7		
Actual Number of Electors		1,405	1,245

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	290
As Freemen	272
Total	562
Deduct Double entries	2
Net Number	560*

Number of Burgesses	2,661
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	1,485
Number of Burgesses on the Parliamentary Register	1,131

The Small Tenements Act appears to have been adopted in almost all of the 14 Parishes.

The Gross Estimated Rental—	£
In 1856 was	64,016
The present Gross Estimated Rental is	88,359
Increase	24,343

The Rateable Value—	£	
In 1856 was	48,475	Increase since 1856 £23,556
In 1862 immediately before the date of the Union Assessment Committee Act it was	51,203	
The present Rateable Value is	72,031	since 1862 £20,828

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	88,971
The Gross Estimated Rental of the same description of Property according to the Valuation List is.	82,403

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	1,512
£6 and under £7	375
£7 and under £8	326
£8 and under £9	175
£9 and under £10	62
£10 and over	1,239
	3,689

At a Rateable Value of—	
£4 and under £5 is	583
£5 and under £6	435
£6	150
Above £6 and under £7	106
£7 and under £8	122
£8 and under £9	124
£9 and under £10	100
£10 and over	1,016

The Clerk to the Guardians states that the Gross Estimated Rental is supposed to represent the full rack rent.

A deduction of from 10 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and above £7 10*s.*, and of from 15 to 35 per cent. in the case of Houses under that amount.

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* With reference to the number of the Working Class on the Register it is stated that the number of Gardeners is large, owing to the business of seed growing, &c. being carried on to a considerable extent. Bakers who have been included, and who have shops, do their own work and carry out their own bread, in some cases perhaps with occasional assistance. Many keepers of Publichouses and Beerhouses are very commonly engaged in some other occupation of labour, or are men of the Working Class who are put into the houses by the Brewers and Merchants to retail beer rather as their servants than in any other capacity, of course doing all the work incidental to the business.

43. COVENTRY.

Population in 1831 -	27,298	Population in 1861 -	41,647	Increase - 14,349
		Population in 1866 (computed) -	44,298	Increase - 17,000

Inhabited Houses in 1861 - - - 9,154

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - - -	529	1,056	527
Freemen - - - -	2,756	3,911*	1,155
Total - -	3,285	4,967	1,682

		Number who voted at the last General Election.
Actual Number of Electors - - - (No Double entries on Register.)	4,967	4,791

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - -	328
As Freemen - - - - - -	3,140
Total - - - - - -	3,468†

Number of Burgesses - - - - - - - - -	4,236
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	1,893
Number of Burgesses on the Parliamentary Register - - - -	2,472

The Parliamentary and Municipal Boundaries are not conterminous, but the difference affects only a small portion of the Voters.

The Small Tenements Act is in force.

The Gross Estimated Rental—	£
In 1856 was - - -	124,359
The present Gross Estimated Rental is - - - - -	139,134
Increase - -	14,775

The Rateable Value—	£	
In 1856 was - -	107,074	Increase since 1856 £10,017
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	122,705	
The present Rateable Value is - - -	117,091	Decrease since 1862 £5,614

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	141,822
The Gross Estimated Rental of the same description of Property according to the Poor Rate is -	130,718

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	1,905
£6 and under £7 - - -	1,061
£7 and under £8 - - -	1,638
£8 and under £9 - - -	474
£9 and under £10 - - -	541
£10 and over - - - -	2,120‡
	7,739

At a Rateable Value of—	
£4 and under £5 is - - -	1,164
£5 and under £6 - - -	1,073
£6 - - - - -	1,499
Above £6 and under £7 - -	373
£7 and under £8 - - -	505
£8 and under £9 - - -	489
£9 and under £10 - - -	193
£10 and over - - - -	1,612

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth of the Gross Rental is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

A weekly Rental of 3*s.* 3*d.* represents a Gross Estimated Rental of £7 5*s.*, and a Rateable Value of £6.

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* 608 of the Freemen are £10 Occupiers although on the Register as Freemen only.

† There are a large number of watchmakers on the Register who come precisely within the description of persons mentioned in the fourth paragraph of the circular of the Poor Law Board working daily at their trade, and for the most part having an apprentice or two; these and the operative weavers constitute the majority of the Working Classes on the Register.

‡ The fact that £10 Occupiers who are also Freemen are only on the Register as Freemen explains the large excess of Male Occupiers at £10 Gross Estimated Rental over the £10 Occupiers on the Register.

44. CRICKLADE.

Population in 1831	28,494	Population in 1861	36,893	Increase - 8,399
		Population in 1866 (computed)	37,608	Increase - 9,114

Inhabited Houses in 1861 - - - 7,676

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	
£10 Occupiers	Qualifications not distinguished	2,008	
Ancient Right Qualifications		86	
Total	1,534	2,094	Increase - 560

Double entries on Register of 1865-6 :—

As £10 Occupiers	30	65	Number who voted at the last General Election.
As £10 Occupiers and Ancient Right Qualifications	35		
Actual Number of Electors		2,029	1,637

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	627
Ancient Right Qualifications	19
Total	646
Deduct double entry	3
Net Number	643*

There are 51 Parishes in this Borough. The Small Tenements Act has been adopted in a majority of them.

The Gross Estimated Rental—	£
In 1856 was	255,622
The present Gross Estimated Rental is	313,347
Increase	57,725

The Rateable Value—	£	
In 1856 was	204,262	Increase since 1856 £54,743
In 1862 immediately before the date of the Union Assessment Committee Act it was	209,723	since 1862 £49,282
The present Rateable Value is	259,005	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	299,119†
The Gross Estimated Rental of the same description of Property according to the Valuation List is	268,334†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	4,147
£6 and under £7	223
£7 and under £8	162
£8 and under £9	160
£9 and under £10	150
£10 and over	2,161
	7,003

At a Rateable Value of—	
£4 and under £5 is	399
£5 and under £6	248
£6	40
Above £6 and under £7	163
£7 and under £8	241
£8 and under £9	187
£9 and under £10	133
£10 and over	1,727

The Gross Estimated Rental is stated to represent the full rack rent.

In 19 Parishes a deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10; in 16 Parishes a deduction of 20 per cent.; in one Parish a deduction of from 15 to 20 per cent.; in one of from 10 to 25 per cent.; and in 14 Parishes of 15 per cent. on Houses, 10 per cent. on Buildings and Land, and 20 per cent. on Cottages, under £6 rent.

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* With reference to the number of the Working Class on the Register it is stated that there is a large number of operatives employed at the factory of the Great Western Railway Company at New Swindon.

† With reference to the difference between the two assessments it is stated that in the Parishes in the Malmsbury Union there has been a very considerable increase in the Income Tax Assessment for 1864-5, whilst no corresponding increase has been made in the Valuation Lists. As regards the Parishes in the Cirencester Union, the difference is accounted for by the lower rate at which house and cottage property is taken in the Poor Rate. Owing to the extensive area comprised in this Borough great difficulty has been experienced in comparing the two Assessments, and the comparison is still very imperfect.

45. DARTMOUTH.

Population in 1831 - 4,597	Population in 1861	- 4,444	Decrease	- 153
	Population in 1866 (computed)	- 4,412	Decrease	- 185

Inhabited Houses in 1861 - - - 825

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - - -	221	294	73	—
Freemen - - - - -	22	1	—	21
Total - -	243	295	73	21
			Net Increase. 52	

Double entries on Register of 1865–6 :—

As £10 Occupiers - - - - 13

Actual Number of Electors - - 282

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 21

Number of Burgesses - - - - - - - - - 339

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - None.

Number of Burgesses on the Parliamentary Register - - - - - - 224

The Gross Estimated Rental—	£
In 1856 was - - - - -	14,672
The present Gross Estimated Rental is - - - - - -	15,226
Increase - - -	554

The Rateable Value—	£	
In 1856 was - - -	10,987	Increase since 1856 £1,391
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	10,705	since 1862 £1,673
The present Rateable Value is - - - -	12,378	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	16,576
The Gross Estimated Rental of the same description of Property according to the Valuation List is	14,879

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	318
£6 and under £7 - - - -	40
£7 and under £8 - - - - -	17
£8 and under £9 - - - -	43
£9 and under £10 - - -	15
£10 and over - - - -	437
	870

At a Rateable Value of—	
£4 and under £5 is - - - -	48
£5 and under £6 - - - -	23
£6 - - - - - - -	26
Above £6 and under £7 - - - -	33
£7 and under £8 - - - - -	18
£8 and under £9 - - - - -	111
£9 and under £10 - - -	54
£10 and over - - - -	312

The Gross Estimated Rental is stated to represent the full rack rent.

In the Parishes of Townstal, St. Petrox, and St. Saviour a deduction of from 15 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6, and of one fifth or one third in the case of Houses at and under £6. In the Parish of Stokefleming one fourth is allowed for Houses above £6 and under £10, and one third for Houses at and under £6.

46. DERBY.

Population in 1831	- 23,627	Population in 1861	- 43,091	Increase	- 19,464
		Population in 1866 (computed)	- 44,388	Increase	- 20,761

Inhabited Houses in 1861 - - 8,981

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	1,012	2,196	1,184	—
Freemen - -	372	336	—	36
Total - -	1,384	2,532	1,184	36
			Net Increase. 1,148	

Double entries on Register of 1865–6 :—

As £10 Occupier - -	1	82	Number who voted at the last General Election.
As £10 Occupiers and Freemen	81		
Actual Number of Electors - -		2,450	2,120

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - -	533
As Freemen - - - -	174
Total - - -	707
Deduct Double entries -	18
Net Number - - -	689*

Number of Burgesses - - - - - - - - -	6,001
Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him	2,304
Number of Burgesses on the Parliamentary Register - - - -	2,223

The Small Tenements Act is in force in all the Parishes. The number of Burgesses before its adoption was 2,471.

The Gross Estimated Rental—	£	**The Rateable Value**—	£	
In 1856 was - - - -	151,673	In 1856 was - - -	126,282	Decrease since 1856 £1,455
The present Gross Estimated Rental is - - - - -	154,701	In 1862 immediately before the date of the Union Assessment Committee Act it was - -	129,668	
Increase - - - -	3,028	The present Rateable Value is - - -	124,827	since 1862 £4,841

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	154,510
The Gross Estimated Rental of the same description of Property according to the Valuation List is	147,648

The Number of Male Occupiers:—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is - - - -	2,163	£4 and under £5 is - - -	1,102
£6 and under £7 - - -	585	£5 and under £6 - -	1,545
£7 and under £8 - - -	1,488	£6 - - - - - -	386
£8 and under £9 - - -	582	Above £6 and under £7 - -	589
£9 and under £10 - - -	432	£7 and under £8 - - -	495
£10 and over - - - -	2,619	£8 and under £9 - - -	583
		£9 and under £10 - - -	230
	7,869	£10 and over - - -	1,755

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses under £6, and of 20 per cent. above £6.

In the case of compounded Tenements, where the Landlord pays the Rates, the Assessment Committee, when they first settled the Valuation Lists, decided that 10 per cent. was the proportion to be deducted for Rates in estimating the Gross Rental.

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* It is stated that the Midland Railway Company's Works, which are very extensive in Derby, and find employment for a large number of men, as also some large iron works, are probably the cause of the number of the Working Class on the Register being somewhat above the average.

47. DEVIZES.

Population in 1831 -	6,367	Population in 1861 -	6,638	Increase	271
		Population in 1866 (computed) -	6,680	Increase	313

Inhabited Houses in 1861 - - 1,336

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	313	365	52	—
Ancient Burgesses - -	23	4	—	19
Total - -	336	369	52	19
			Net Increase. 33	

Double entries on Register of 1865-6 :—

As £10 Occupiers - -	6	10	Number who voted at the last General Election.
As £10 Occupiers and Burgesses	4		
Actual Number of Electors - -		359	190

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 26

Number of Burgesses - - - - - - - - -	421
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	103
Number of Burgesses on the Parliamentary Register - - - - -	288

The Small Tenements Act is in force in three out of the four Parishes.

The Gross Estimated Rental—	£
In 1856 was - - - -	21,073
The present Gross Estimated Rental is - - - -	23,481
Increase - - -	2,408

The Rateable Value—	£	
In 1856 was - -	16,959	Increase since 1856 £2,757
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	16,161	since 1862 £3,555
The present Rateable Value is - - -	19,716	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	23,525
The Gross Estimated Rental of the same description of Property according to the Valuation List is	22,550

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	314
£6 and under £7 - - -	141
£7 and under £8 - - -	24
£8 and under £9 - - -	49
£9 and under £10 - -	14
£10 and over - -	374
	916

At a Rateable Value of—	
£4 and under £5 is - - -	158
£5 and under £6 - - -	92
£6 - - - - - -	28
Above £6 and under £7 - -	28
£7 and under £8 - - -	22
£8 and under £9 - - -	41
£9 and under £10 - - -	22
£10 and over - - - -	316

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 10 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

48. DEVONPORT.

Population in 1831 - 44,454	Population in 1861	-	64,783	Increase -	20,329
	Population in 1866 (computed)	-	73,624	Increase -	29,170

Inhabited Houses in 1861 - - - - 5,434

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	1,777	2,860	1,083

			Number who voted at the last General Election.
Double entries on Register of 1865–6:— As £10 Occupiers - -	About	40	
Estimated Number of Electors	-	2,820	2,582

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - -	1,405
Deduct Double entries - - -	8
Net Number - - -	1,397*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - -	114,737
The present Gross Estimated Rental is - - - - -	132,597
Increase - - - -	17,860

The Rateable Value—	£	
In 1856 was - -	87,879	Increase since 1856
The present Rateable Value is - - - -	102,484	£14,605

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - -	133,060
The Gross Estimated Rental of the same description of Property according to the Poor Rate is	130,129

The Number of Male Occupiers:—

At a Gross Estimated Rental—	
Under £6 is - - -	134
£6 and under £7 - - -	86
£7 and under £8 - - -	52
£8 and under £9 - - -	105
£9 and under £10 - - -	29
£10 and over - - - -	3,919†
	4,325

At a Rateable Value of—	
£4 and under £5 is - -	130
£5 and under £6 - - -	37
£6 - - - - -	135
Above £6 and under £7 - - -	14
£7 and under £8 - - -	320
£8 and under £9 - - - -	125
£9 and under £10 - - -	263
£10 and over - - -	3,226

The Gross Estimated Rental is stated to represent the full rack rent.

In the Parish of East Stonehouse a deduction of one fifth, and in the Parish of Stoke Damarel of one fourth, is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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[*] The large proportion of the working classes on the Register is accounted for by the fact of a large number of artizans being employed in the Royal Dock and Keyham yards.

[†] With regard to the parish of East Stonehouse it is stated that the difference between the number of Male Occupiers at £10 and over, Gross Estimated Rental, and the number of Electors is occasioned by the breaks in occupation and a large number of persons being struck off the Register by the Revising Barrister for various reasons, the chief one being the non-qualification of Government Officials at the Royal Marine Barracks, Royal Naval Hospital, and Royal William Victualling Yard. With regard to Stoke Damerel it is stated that in that parish many hundreds are struck off the Register by the Revising Barrister annually.

49. DORCHESTER.

Population in 1831 -	4,940	Population in 1861 -	6,823	Increase - 1,883
		Population in 1866 (computed) -	7,048	Increase - 2,108

Inhabited Houses in 1861 - - 1,030

Number of Electors on Parliamentary Register :—

	1832-3.		1865-6.	Increase.
£10 Occupiers and Ancient Right Qualifications -	322	£10 Occupiers -	451	129

		Number who voted at the last General Election.
Double entries on Register of 1865-6 :—		
As £10 Occupiers - - - - -	19	
Actual Number of Electors - - -	432	387

Number of Working Classes on the present Parliamentary Register - - 152*

Number of Burgesses - - - - - - - - - -	586
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	112
Number of Burgesses on the Parliamentary Register - - - - -	386

The Small Tenements Act has been adopted in one of the four parishes ; viz., Fordington.

The Gross Estimated Rental—	£
In 1856 was - - - - -	20,134
The present Gross Estimated Rental is - - - - - -	20,455
Increase - - -	321

The Rateable Value—	£	
In 1856 was - -	14,571	Increase since 1856 £1,797
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	13,444	since 1862 £2,924
The present Rateable Value is - - - -	16,368	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	26,070†
The Gross Estimated Rental of the same description of Property according to the Valuation List is	19,808†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	244
£6 and under £7 - - - -	48
£7 and under £8 - - - -	36
£8 and under £9 - - - -	34
£9 and under £10 - - - -	19
£10 and over - - - - -	447
	828

At a Rateable Value of—	
£4 and under £5 is - - -	142
£5 and under £6 - - -	32
£6 - - - - -	12
Above £6 and under £7 - -	35
£7 and under £8 - - -	16
£8 and under £9 - - -	57
£9 and under £10 - - -	31
£10 and over - - -	371

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the large number of working classes on the Register it is stated that many of the persons who rent £10 houses in the borough take them with a view of letting out again to lodgers.

† It is stated that the Gross Estimated Rental is on an average at least 20 per cent. less than the Income Tax Assessment. The subject is to be brought under the consideration of the Assessment Committee.

50. DOVER.

Population in 1831	15,645	Population in 1861	25,325	Increase	9,680
		Population in 1866 (computed)	27,022	Increase	11,377

Inhabited Houses in 1861 - - 3,991

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	367	1,575	1,208	—
Freemen	1,284	839	—	445
Total	1,651	2,414	1,208	445
			Net Increase. 763	

Double entries on Register of 1865–6 :—

As £10 Occupiers	5	96	Number who voted at the last General Election.
As £10 Occupiers and Freemen	91		
Actual Number of Electors		2,318	1,944

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	679
As Freemen	194
Total	873
Deduct Double entries	28
Net Number	845*

Number of Burgesses	2,021
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	213
Number of Burgesses on the Parliamentary Register	1,549

The Small Tenements Act has been adopted in some of the Parishes. The 59 Geo. 3. c. 12. appears to be in force in the Parish of St. Mary the Virgin. Parliamentary Return, No. 33, 1862.

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was	86,877	In 1856 was	75,248	Increase since 1856 £15,930
The present Gross Estimated Rental is	109,758	In 1862 immediately before the date of the Union Assessment Committee Act it was	81,427	since 1862 £9,751
Increase	22,881	The present Rateable Value is	91,178	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	113,267‡
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is	104,803‡

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	144	£4 and under £5 is	230
£6 and under £7	175	£5 and under £6	275
£7 and under £8	211	£6	125
£8 and under £9	298	Above £6 and under £7	310
£9 and under £10	170	£7 and under £8	212
£10 and over	2,340†	£8 and under £9	495
		£9 and under £10	122
	3,338	£10 and over	1,849

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 15 to 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

Houses rated at £6 10*s.* would be let at 3*s.* 6*d.* a week.

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* In consequence of the great public works carried on for some years past, such as Fortifications, Admiralty Pier, Improvement of the Harbour, and Termini of two Railways, there has been a great influx of the working-classes into Dover.

† In explanation of the difference between the number of Male Occupiers at £10 Gross Estimated Rental and the number of £10 Occupiers on the Register it is stated that the greater portion of the Freemen are residing in houses included in the 2,340 rated at £10 and upwards, also that a great number of houses have been lately erected, the occupation of which has not been sufficiently long to qualify.

‡ The difference between the two assessments is attributed to the fact that the charge for the Income Tax is levied on the actual rent, whereas the Poor Rate Assessment is on such a rental as the Overseers and the Assessment Committee consider to be fair.

51. DROITWICH.

Population in 1831 - 5,949	Population in 1861	- 7,086	Increase	-	1,137
	Population in 1866 (computed)	- 7,081	Increase	-	1,132

Inhabited Houses in 1861 - - 1,504

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - -	236	398	162	—
Freemen or Burgesses - -	7	2	—	5
Total - - -	243	400	162	5
			Net Increase. 157	
Actual Number of Electors - - (No Double entries on Register.)		400	No contest at the last General Election.	

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - -	118
Deduct Double entry - - -	1
Net Number - -	117*

The Parliamentary and Municipal Boroughs are not conterminous.

The Small Tenements Act has been adopted in several of the Parishes.

The Gross Estimated Rental—	£
In 1856 was - - -	52,186
The present Gross Estimated Rental is - - - - -	63,714
Increase - - -	11,528

The Rateable Value—	£	
In 1856 was - - -	45,632	Increase since 1856 £9,951
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	48,295	since 1862 £7,288
The present Rateable Value is - - -	55,583	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	51,983
The Gross Estimated Rental of the same description of Property according to the Valuation List is	50,488

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - - -	698
£6 and under £7 - -	98
£7 and under £8 - - - - -	49
£8 and under £9 - - - -	42
£9 and under £10 - - - -	15
£10 and over - - - -	391
	1,293

At a Rateable Value of—	
£4 and under £5 is - - - -	398
£5 and under £6 - - - - -	61
£6 - - - - -	4
Above £6 and under £7 - - -	43
£7 and under £8 - - - -	17
£8 and under £9 - - - -	41
£9 and under £10 - - - -	18
£10 and over - - - -	343

The Gross Estimated Rental it is stated is assumed to represent the fair value.

In the several Parishes, with the exception of St. Andrew and St. Peter, Droitwich, a deduction of from 15 to 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10. In St. Andrew and St. Peter the deduction varies from 15 to 25 per cent.

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* The persons included in the Return as Working Farmers are occupiers of a few acres of land, working on it themselves, and employing no regular labourers.

52. DUDLEY.

Population in 183 - 23,430	Population in 1861	-	44,975	Increase -	21,545
	Population in 1866 (computed)	-	48,953	Increase -	25,523

Inhabited Houses in 1861 - - 8,714

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - - -	670	1,358	688

		Number who voted at the last General Election.
Actual Number of Electors - - (No Double entries on Register.)	1,358	801

Number of Working Classes on the present Parliamentary Register - - 247

Number of Burgesses - - - - - - - - - - 6,363

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 4,339

Number of Burgesses on the Parliamentary Register - - - - - - 1,307

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - -	86,571
The present Gross Estimated Rental is - - - - - -	142,191
Increase - - - -	55,620

The Rateable Value—	£	
In 1856 was - - - -	60,663	Increase since 1856 £43,213
In 1862 immediately before the date of the Union Assessment Committee Act it was - - - -	79,331	
The present Rateable Value is - - - -	103,876	since 1862 £24,545

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	88,430
The Gross Estimated Rental of the same description of Property according to the Valuation List is	105,052

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is - - - -	3,134	£4 and under £5 is - - - -	2,183
£6 and under £7 - - -	2,161	£5 and under £6 - - -	816
£7 and under £8 - - -	718	£6 - - - - - - -	323
£8 and under £9 - - -	392	Above £6 and under £7 - - -	177
£9 and under £10 - - -	142	£7 and under £8 - - - - -	55
£10 and over - - - -	1,389	£8 and under £9 - - -	416
		£9 and under £10 - - -	178
	7,936	£10 and over - - - -	795

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £10, of 25 per cent. in the case of Houses at £6 and under £10, and of 35 per cent. in the case of Houses under £6.

The Occupiers themselves usually pay the rates for tenements above the Rateable Value of £6.

53. DURHAM.

Population in 1831 - 10,135	Population in 1861	-	14,088	Increase -	3,953
	Population in 1866 (computed)	-	14,561	Increase -	4,426

Inhabited Houses in 1861 - - - 2,007

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	314	648	334
Freemen - - -	492	501	9
Total - - -	806	1,149	343

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	23	
As £10 Occupiers and Freemen	70	93
Actual Number of Electors - - - -		1,056

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - - -	61
As Freemen - - - - - -	356
Total - - - -	417
Deduct Double entries - -	2
Net Number - - - -	415

Number of Burgesses - - - - - - - - -	1,245
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	133
Number of Burgesses on the Parliamentary Register - - - -	718

The Small Tenements Act is in force in four of the ten Parishes within this Borough. The number of Burgesses immediately preceding its adoption was 1,016.

The Gross Estimated Rental—	£
In 1856 was - - - - -	31,071
The present Gross Estimated Rental is - - - - -	40,430
Increase - - -	9,359

The Rateable Value—	£	
In 1856 was - -	24,581	Increase since 1856 £8,336
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	30,831	
The present Rateable Value is - - -	32,917	since 1862 £2,086

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	38,560
The Gross Estimated Rental of the same description of Property according to the Valuation List is	37,820

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	939
£6 and under £7 - - -	175
£7 and under £8 - - - -	89
£8 and under £9 - - - -	91
£9 and under £10 - - - -	55
£10 and over - - -	828
	2,177

At a Rateable Value of—	
£4 and under £5 is - - -	154
£5 and under £6 - - - -	184
£6 - - - - - - -	32
Above £6 and under £7 - - -	114
£7 and under £8 - - - -	71
£8 and under £9 - - - -	99
£9 and under £10 - - - -	32
£10 and over - - - -	667

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

54. EVESHAM.

Population in 1831	- 3,991	Population in 1861	- 4,680	Increase	- 689
		Population in 1866 (computed)	- 4,718	Increase	- 727

Inhabited Houses in 1861 - - - 967

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - -	195	323	128	—
Freemen - - - -	164	49	—	115
Total - -	359	372	128	115
			Net Increase. 13	

Double entries on Register of 1865–6 :—

As £10 Occupiers - - -	15	35	Number who voted at the last General Election.
As £10 Occupiers and Freemen -	20		
Actual Number of Electors - -		337	267

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - - -	7
As Freemen - - - -	16
Total - - -	23

Number of Burgesses - - - - - - - - -	617
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	316
Number on the Parliamentary Register - - - - - -	288

The Small Tenements Act is in force. Before its adoption the number of Burgesses was 419.

The Gross Estimated Rental—	£
In 1856 was - - - -	18,585
The present Gross Estimated Rental is - - - - - -	19,562
Increase - - -	977

The Rateable Value—	£	
In 1856 was - -	14,656	Increase since 1856 £2,482
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	14,741	since 1862 £2,397
The present Rateable Value is - - -	17,138	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	19,736
The Gross Estimated Rental of the same description of Property according to the Valuation List is	18,983

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	364
£6 and under £7 - - -	66
£7 and under £8 - - -	35
£8 and under £9 - - -	30
£9 and under £10 - - -	9
£10 and over - - - -	329
	833

At a Rateable Value of—	
£4 and under £5 is - - -	172
£5 and under £6 - - - - -	33
At £6 - - - - - - -	—
Above £6 and under £7 - -	33
At £7 and under £8 - - -	7
At £8 and under £9 - - -	36
At £9 and under £10 - - -	6
At £10 and over - - -	287

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £6, and 15 per cent. in the case of houses above £6.

55. EXETER.

Population in 1831 -	33,552	Population in 1861 -	41,749	Increase	8,197
		Population in 1866 (computed) -	42,290	Increase -	8,738

Inhabited Houses in 1861 - - 6,854

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers and Freeholders - -	2,366	1,778 1,013	425
Freemen - - -	586	898	312
Total - -	2,952	3,689	737

Double entries on Register of 1865–6 :—

As £10 Occupiers - - -	113	601	No Contest at the last General Election.
As £10 Occupiers and Freemen or Freeholders - -	488		
Actual Number of Electors - -		3,088	

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - -	361
As Freemen - - - -	113
As Freeholders - - - -	38
Total - - -	512

The Parliamentary and Municipal Boundaries are not conterminous.

The 59 Geo. 3. c. 12. appears to be in force, the limit of rating as fixed by the Vestry being £10 The range allowed by this Act for rating the Landlord instead of the Occupier is from £6 to £20·

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was - - -	180,795	In 1856 was - -	139,100	Increase since 1856 £15,173
The present Gross Estimated Rental is - - - - - -	178,436	In 1862 immediately before the date of the Union Assessment Committee Act it was - -	146,642	since 1862 £7,631
Increase - - -	2,359	The present Rateable Value is - - - -	154,273	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	180,553
The Gross Estimated Rental of the same description of Property according to the Poor Rate or Valuation List is - - - - - - - - -	167,387*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is - - - -	1,788	£4 and under £5 is - - -	554
£6 and under £7 - - -	363	£5 and under £6 - - -	535
£7 and under £8 - - -	336	£6 - - - - - -	139
£8 and under £9 - - -	296	Above £6 and under £7 - -	167
£9 and under £10 - - -	240	£7 and under £8 - - -	348
£10 and over - - - -	2,766†	£8 and under £9 - - -	293
		£9 and under £10 - - -	251
	5,789	£10 and over - - - -	2,667

The Gross Estimated Rental is stated to represent generally the full rack rent.

In three Parishes a deduction of or about 33½ per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10; in two Parishes a deduction of from 25 to 33½ per cent.; in two Parishes from 20 to 33½ per cent.; in one Parish from 20 to 50 per cent.; in one Parish from 15 to 50 per cent.; in two Parishes from 20 to 25 per cent.; in one Parish from 15 to 25 per cent.; in seven Parishes 20 per cent.; in one Parish from 15 to 20 per cent.; in one Parish from 12½ to 20 per cent.; in one Parish about 12½ per cent.; and in five Parishes 20 per cent on Houses from £6 to £10, and 33½ per cent. on Houses at and under £6.

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* In the parishes in the City it is stated that in some instances there appears to be great irregularity in the Poor Rates which are not made upon the actual rental.

† With reference to the excess of Male Occupiers at £10 Gross Estimated Rental over the Electors on Register as £10 Occupiers it is stated as regards Exeter that many of the Occupiers had not rented a sufficient length of time, and that many are rated at £10 who do not pay that sum. As regards the parishes in St Thomas's Union included in the City it is stated that many persons who are placed on the Lists by the Overseers, being objected to, are struck off, as they do not attend the Revision Court to prove their qualifications, and that a considerable number of the tenements which are rated at £10 and upwards are not occupied solely by the persons rated.

56. EYE.

Population in 1831	7,015	Population in 1861	7,038	Increase	23
		Population in 1866 (computed)	6,804	Decrease	211

Inhabited Houses in 1861 - - - 1,405

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	200	329	129	—
Freemen	53	17	—	36
Total	253	346	129	36
			Net Increase. 93	

Double entries on Register of 1865-6:—

As £10 Occupier	1	7
As £10 Occupiers and Freemen	6	
Actual Number of Electors		339

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	30
Deduct Double entries	2
Net Number	28

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force almost throughout the whole Borough.

The Gross Estimated Rental—	£
In 1856 was	39,818
The present Gross Estimated Rental is	42,917
Increase	3,099

The Rateable Value—	£	
In 1856 was	31,305	Increase since 1856 £5,774
In 1862 immediately before the date of the Union Assessment Committee Act it was	31,471	since 1862 £5,608
The present Rateable Value is	37,079	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	44,678
The Gross Estimated Rental of the same description of Property according to the Valuation List is	42,884

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	879
£6 and under £7	28
£7 and under £8	30
£8 and under £9	27
£9 and under £10	16
£10 and over	307
	1,287

At a Rateable Value of—	
£4 and under £5 is	65
£5 and under £6	36
£6	23
Above £6 and under £7	13
£7 and under £8	31
£8 and under £9	33
£9 and under £10	28
£10 and over	288

The Gross Estimated Rental it is stated is presumed to represent the full rack rent.

In the several Parishes, with the exception of Hoxne and Denham, a deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and in the Parishes named a deduction of from 25 to 33 per cent. is made.

57. FINSBURY.

Population in 1831 - 234,629	Population in 1861 -	387,278	Increase -	152,642
	Population in 1866 (computed) -	423,560	Increase -	188,931
Inhabited Houses in 1861 - -		44,410		

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - - -	10,039	25,491	15,452

		Number who voted at the last General Election.
Double entries on Register of 1865–6 :— As £10 Occupiers - - - - -	30	
Actual Number of Electors - - - -	25,461	13,127

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - 4,181*

Local Acts for rating Owners instead of Occupiers are in force in the following Parishes :—

Clerkenwell. 15 Geo. 3. c. 23., with a rating limit of under £10 annual rent or value.

Islington. 20 & 21 Vict. c. 118., with a rating limit of £20 yearly rent or value, except where houses are let for a period less than one year, or let furnished or in separate apartments.

St. Andrew and St. George the Martyr, Holborn. 6 Geo. 4. c. 175., with a rating limit of £20 yearly value, except where houses are let at rents payable at any shorter period than quarterly, or let in lodgings or separate apartments.

St. George, Bloomsbury, and St. Giles in the Fields. 11 Geo. 4. c. 10., with a rating limit of less than £30 yearly assessment or valuation, except where houses are let at rents payable at any shorter period than quarterly, or let in lodgings or separate apartments.

St. Luke. 48 Geo. 3. c. 97., with a rating limit of £15, except where houses are let to weekly or monthly tenants, or at rents payable at a shorter period than quarterly.

St. Sepulchre. 12 Geo. 3. c. 68., limited to houses let in separate apartments or let furnished at rents under £10.

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was - - - -	1,624,296	In 1856 was - -	1,291,274	Increase since 1856
The present Gross Estimated Rental is - - - - - -	1,997,600	The present Rateable Value is - - -	1,706,400	£415,126
Increase - - - -	373,304			

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	2,032,567
The Gross Estimated Rental of the same description of Property according to the Valuation List is	1,921,472

The Number of Male Occupiers :—

—	Gross Estimated Rental of								Rateable Value of							
	Under £4.	£4 and under £5.	£5 and under £6.	£6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.	£4 and under £5.	£5 and under £6.	£6.	Above £6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.
Charterhouse - -	No Return.								No Return.							
Clerkenwell, St. James	56	60	36	95	56	85	41	5,681	61	129	—	85	37	111	61	5,638
Holborn Union - -	—	—	7	16	25	17	9	3,437	—	7	3	13	26	17	9	3,437
Islington, St. Mary -	22	44	28	139	36	343	58	21,176	390	256	553	—	246	723	95	19,386
Rolls Liberty - -	—	—	—	—	—	—	1	199	2	—	—	—	—	—	1	197
Glasshouse Yard Liberty	—	—	—	—	—	—	—	89	—	1	—	—	—	—	—	88
Giles, St., & St. George, Bloomsbury - -	—	1	—	—	1	6	3	2,859	—	1	2	—	1	7	3	2,787
Luke, St., Middlesex -	1	7	19	28	49	217	136	5,158	264	157	385	—	228	218	135	4,235
Stoke Newington -	—	9	13	58	3	28	1	1,069	29	9	19	—	12	11	1	1,031
TOTAL - -	79	121	103	336	170	696	299	39,668	746	560	962	98	550	1,087	305	36,799

The above Return includes the number of Tenements in respect of which the Owners are rated instead of the Occupiers in the following cases :—

Clerkenwell - -	—	12	2	11	16	23	12	391	16	56	—	30	—	25	2	391
Holborn Union - -	—	—	7	13	24	12	9	682	Not separately returned.							
Islington - -	21	44	28	111	36	275	58	3,829	358	254	488	—	246	639	94	2,125
St. Luke, Middlesex -	1	7	19	27	45	214	183	1,777	Not separately returned.							

Clerkenwell.—A deduction of one fourth is made from the Gross Estimated Rental in ascertaining the Rateable Value. There are a large number of houses let out in separate apartments or floors for which the landlord is rated, but the names of the tenants or lodgers are never entered in the Rate Book. In some instances the landlord lives out of town, but retains an office, counting-house, or workshop in which he transacts business in the daytime. The compound householders are entered by the Collectors on the Register in almost every case, and it is stated that there are even occupiers of houses of £8 rental on the Register of Voters.

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* The return of the number of the Working Classes on the Register for the parish of St. Luke is based upon an estimate. It was ascertained by careful examination that the number on one half of the Register was 269, and 538, or double that number, was inserted in the Return.

Holborn Union.—The parishes and places comprised in this union which are included in the borough are Furnival's Inn, Saffron Hill, Hatton Garden, Ely Rents, Ely Place, St. Andrew, Holborn-above-the-Bars, and St. George-the-Martyr, St. Sepulchre, Staple Inn, and Lincoln's Inn.

The Gross Estimated Rental in all the parishes, with the exception of Lincoln's Inn, represents the full rackrent. The assessment of Lincoln's Inn is made under an Act of Parliament which fixes the amount to be paid as the contribution of the Inn. There is no fixed scale of deductions in arriving at the Rateable Value. The Rateable Value in the case of compounded tenements is not the true Rateable Value, but only the reduced value in respect of which the Landlord is charged.

There are 747 compounded houses, of which 682 are of £10 Gross Estimated Rental, but no compounded Occupier has hitherto been placed on the Register.

The houses rated to landlords which are let out in distinct tenements are not distinguished in the Valuation Lists from those which are let to single tenants. No occupier of any such tenement has come on the Register,

Rolls Liberty.—There are in this liberty, not included in the Return, 74 houses of £10 and over Rateable Value let out in distinct tenements, one at £9 and under £10, seven at £8 and under £9, and 16 at £7 and under £8.

St. Giles and St. George, Bloomsbury, United Parishes.—The Gross Estimated Rental is inserted in the rate only in those cases in which the Owners compound, and is the Estimated Rent payable to the Landlord, he paying all rates and taxes, insurance, &c. The Rateable Value entered in the rate is the full Rateable Value, and not the reduced Rateable Value in respect of which the Landlord is charged in composition.

There are 575 tenements assessed to the owners at the Rateable Value of £10 and over, including 232 tenements compounded for, rated at £10 and over Gross Estimated Value. 29 persons rated in respect of those houses are on the Register. The Occupier unless he is the person rated is not placed on the Register.

There are 982 houses for which no Occupier's name appears in the list of voters, because the tenements are rated either to Females or Landlords who compound.

There are 85 houses let out in distinct tenements. The number and value of the separate occupations cannot be ascertained without a house-to-house visitation.

The difference between the Returns of Male Occupiers, Gross Estimated Rental, and Rateable Value, is explained by the fact that the former was made in August 1865 from the Lady-day rate, and the latter in December from the Michaelmas rate.

St. Mary, Islington, Parish.—The Gross Estimated Rental represents the full rack rent. It is the full rent paid by the tenant to the Landlord when the latter pays the rates, &c.

The Rateable Value is arrived at by deducting from the Gross Estimated Rental one fifth, except when the Owners compound, in which case one half is deducted, the remaining half being inserted in the rate as the Rateable Value.

There are 3,829 compounded houses of £10 and over Gross Estimated Rental; scarcely any, if any, of the Occupiers get upon the Register; they do not claim.

It is estimated that there are about 2,000 houses let out in distinct tenements. There is nothing in the Rate Book to indicate the number or value of the separate occupations. The Occupiers are not on the Register.

About 2,000 persons are not placed on the Register yearly, because of nonpayment of assessed taxes.

St. Luke, Middlesex, Parish.—The Gross Estimated Rental represents the full rackrent, and in the case of compounded houses the full rent paid by the tenants, the Landlord paying tenants' rates and taxes.

The Rateable Value is arrived at by deducting one fifth from the Gross Estimated Rental, except in the case of compounded houses, when a deduction of one half is made, the remaining half being entered as the Rateable Value.

The number of compounded houses is 2,273.

There is a model lodging-house in Golden Lane, containing 176 rooms, let at from 4*s.* 6*d.* to 5*s.* 6*d.* per pair. There are also a great many houses let out in distinct tenements. The tenants' names do not appear on the rate, and there is nothing to indicate the number or value of the separate occupations. It would not be possible to obtain this information without a house-to-house visitation.

Stoke Newington Parish.—The Gross Estimated Rental represents the full rackrent, and in the case of compounded houses the full rent paid by the tenant to the Landlord, including the rates for which the Landlord is assessed.

Compounded houses are rated at one half the Estimated Rental. In other cases a deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value, except when tenants covenant to do the repairs, and in those cases 10 per cent. only is deducted.

There are no houses in the parish let out in distinct tenements.

58. FROME.

Population in 1831 -	10,370	Population in 1861 -	9,522	Decrease -	848
		Population in 1866 (computed) -	9,224	Decrease -	1,146

Inhabited Houses in 1861 - - 2,066

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - - -	322	414	92

		Number who voted at the last General Election.
Actual Number of Electors - - (No Double entries on Register.)	414	389

Number of Working Classes on the present Parliamentary Register - 60

The Small Tenements Act is in force.

The Gross Estimated Rental—	£
In 1856 was - - - -	25,597
The present Gross Estimated Rental is - - - -	22,307
Decrease - - -	3,290

The Rateable Value—	£	
In 1856 was - -	18,448	Decrease since 1856 £246
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	16,776	Increase since 1862 £1,426
The present Rateable Value is - - - -	18,202	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	23,001
The Gross Estimated Rental of the same description of Property according to the Valuation List is	22,007

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	1,160
£6 and under £7 - - - -	70
£7 and under £8 - - - -	63
£8 and under £9 - - - -	21
£9 and under £10 - - - -	87
£10 and over - - -	405*
	1,806

At a Rateable Value of—	
£4 and under £5 is - - - -	221
£5 and under £6 - - - -	93
£6 - - - - - - -	—
Above £6 and under £7 - -	32
£7 and under £8 - - - -	19
£8 and under £9 - - - -	123
£9 and under £10 - - - -	38
£10 and over - - - - -	332

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses under £10 and over £6.

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* The Clerk to the Guardians states that in the Frome Rate Book the names of large Occupiers appear frequently in the tythings, and that in checking it may have occurred in a few instances that names have been taken more than once.

59. GATESHEAD.

Population in 1831	- 15,617	Population in 1861	- 33,587	Increase	17,970
		Population in 1866 (computed)	- 38,495	Increase	- 22,878

Inhabited Houses in 1861 - - 4,391

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	454	1,172	718

Double entries on Register of 1865–6 - - - -	7	No Contest at the last General Election.
Actual Number of Electors - -	1,165	

Number of Working Classes on the present Parliamentary Register - 110

Number of Burgesses - - - - -	2,619
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	1,433
Number of Burgesses on the Parliamentary Register - - - -	1,094

The Small Tenements Act is in force.

The Gross Estimated Rental—	£
In 1856 was - - -	73,556
The present Gross Estimated Rental is - - - -	118,954
Increase - -	45,398

The Rateable Value—	£	
In 1856 was - -	57,749	Increase since 1856 £26,841
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	63,969	since 1862 £20,621
The present Rateable Value is - -	84,590	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	90,537
The Gross Estimated Rental of the same description of Property according to the Valuation List is	89,773

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	3,793
£6 and under £7 - -	875
£7 and under £8 - - -	495
£8 and under £9 - - -	399
£9 and under £10 - - -	182
£10 and over - - -	1,466
	7,210*

At a Rateable Value of—	
£4 and under £5 is - - - -	388
£5 and under £6 - - - -	141
£6 - - - - - -	40
Above £6 and under £7 - -	16
£7 and under £8 - - -	223
£8 and under £9 - - -	150
£9 and under £10 - -	60
£10 and over - - - -	1,190

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10; but nearly the whole are compounded for, and the reduced Rateable Value is entered in the Valuation List instead of the Rate Book alone.

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* It appears that of these occupations the following are brought within the provisions of the Small Tenements Act; viz., 456 at £7 and under £8, 235 at £8 and under £9, 106 at £9 and under £10, and 94 at £10 and above. The actual rent paid to the landlord constitutes the gross rental, and the landlord is rated upon one half of the rent, less one sixth.

60. GLOUCESTER.

Population in 1831 - 13,000	Population in 1861	- 16,512	Increase	- 3,512
	Population in 1866 (computed)	- 16,006	Increase	- 3,006

Inhabited Houses in 1861 - 2,854

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	802	1,298	496	—
Freemen - -	725	548	—	177
Total - -	1,527	1,846	496	177
			Net Increase. 319	

Double entries on Register of 1865–6:—

As £10 Occupiers - - -	43	131	Number who voted at the last General Election.
As £10 Occupiers and Freemen	88		
Actual Number of Electors - -		1,715	1,500

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - -	282
As Freemen - - - - - -	199
Total - - -	481
Deduct Double entries - -	33
Net Number - - - -	448*

Number of Burgesses - - - - - -	1,629
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	398
Number of Burgesses on the Parliamentary Register - - - -	1,023

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was - - -	73,262	In 1856 was - -	56,316	Decrease since 1856 £603
The present Gross Estimated Rental is - - - - -	75,203	In 1862 immediately before the date of the Union Assessment Committee Act it was - -	50,942	
Increase - -	1,941	The present Rateable Value is - - -	55,713	Increase since 1862 £4,771

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	73,454
The Gross Estimated Rental of the same description of Property according to the Valuation List is	69,645

The Number of Male Occupiers:—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is - - - -	550	£4 and under £5 is - - -	263
£6 and under £7 - - -	273	£5 and under £6 - - - -	94
£7 and under £8 - - -	190	£6 - - - -	142
£8 and under £9 - - - -	185	Above £6 and under £7 -	65
£9 and under £10 - - -	65	£7 and under £8 - - -	255
£10 and over - - - -	1,698	£8 and under £9 - - -	60
		£9 and under £10 - - -	137
	2,961	£10 and over - - - -	1,290

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the number of the working classes on the Register it is stated that there are extensive railway waggon works in the borough, and that Gloucester being a port, there are several ship building yards and engineers' yards in which carpenters and smiths are employed. The Freemen, many of whom are artizans, stick to the borough on account of their freedom. The rental of houses is very high.

61. GRANTHAM.

Population in 1831	7,427	Population in 1861	11,121	Increase	3,694
		Population in 1866 (computed)	11,247	Increase	3,820

Inhabited Houses in 1861 - - - 2,254

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	202	671	469	—
Freemen	496	215	—	281
Total	698	886	469	281
			Net Increase. 188	

Double entries on Register of 1865–6 :—

			Number who voted at the last General Election.
As £10 Occupiers	85	131	
As £10 Occupiers and Freemen	46		
Actual Number of Electors		755	676

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	86
As Freemen	67
Total	153
Deduct Double entries	2
Net Number	151

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been partially adopted.

The Gross Estimated Rental—	£
In 1856 was	40,389
The present Gross Estimated Rental is	51,249
Increase	10,860

The Rateable Value—	£	
In 1856 was	31,636	Increase since 1856 £10,620
In 1862 immediately before the date of the Union Assessment Committee Act it was	35,456	since 1862 £6,800
The present Rateable Value is	42,256	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	44,684
The Gross Estimated Rental of the same description of Property according to the Valuation List is	42,228

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	656
£6 and under £7	370
£7 and under £8	182
£8 and under £9	56
£9 and under £10	44
£10 and over	700
	2,008

At a Rateable Value of—	
£4 and under £5 is	274
£5 and under £6	459
£6	19
Above £6 and under £7	122
£7 and under £8	63
£8 and under £9	107
£9 and under £10	96
£10 and over	573

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

62. GREENWICH.

Population in 1831	63,172	Population in 1861	139,436	Increase	76,264
		Population in 1866 (computed)	160,086	Increase	96,914

Inhabited Houses in 1861 - - - - 19,365

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - - -	2,714	9,813	7,099

Double entries on Register of 1865–6 :—		Number who voted at the last General Election.
As £10 Occupiers - - - - -	8	
Actual Number of Electors - - - -	9,805	10,824

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - 5,169*

The Small Tenements Act is in force in one of the Parishes. A Local Act, 27 Geo. 2. c. ., provides for the rating of the Owners of Houses let in separate apartments, or for less than three months, in the Parishes of St. Nicholas and St. Paul, Deptford ; another Local Act, 47 Geo. 3. sess. 2. c. 111., with a rating limit not exceeding £12 yearly rent or value, except where the rent is collected at a shorter period than quarterly, is in force in Woolwich ; and another Local Act, 9 Geo. 4. c. 43., with a rating limit not exceeding £15 yearly rent or value, and containing a similar exception, is in force in East Greenwich.

The Gross Estimated Rental—	£
In 1856 was - - -	393,091
The present Gross Estimated Rental is - - - - -	498,694
Increase - - -	105,603

The Rateable Value—	£	
In 1856 was - -	320,282	Increase since 1856 £85,888
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	373,404	since 1862 £32,766
The present Rateable Value is - - -	406,170	

The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - - £ 527,471

The Gross Estimated Rental of the same description of Property according to the Valuation List is 438,094†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	1,758
£6 and under £7 - - - -	854
£7 and under £8 - - -	842
£8 and under £9 - - - -	899
£9 and under £10 - - -	1,213
£10 and over - - - -	13,216
	18,782

At a Rateable Value of—	
£4 and under £5 is - - -	850
£5 and under £6 - - - -	1,147
£6 - - - - - -	787
Above £6 and under £7 - - -	344
£7 and under £8 - - -	1,075
£8 and under £9 - - - -	1,364
£9 and under £10 - - -	1,246
£10 and over - - -	11,107

The Gross Estimated Rental it is stated in the Lewisham Union represents the full rack rent.

In the Parish of Charlton a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 ; in Plumstead and Greenwich a deduction of 25 per cent. ; and in St. Paul and St. Nicholas, Deptford and Woolwich, 30 per cent.

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* The greater part of the Royal Arsenal, Woolwich, is within the Parish of Plumstead in this Borough, and the Royal Dockyard is contiguous to that Parish.

† The Clerk to the Guardians of the Greenwich Union states that he has come to the conclusion that the Gross Estimated Rental shown in the Valuation Lists is below the actual rack rent, especially in the parishes of Saint Nicholas and Saint Paul, Deptford. In the other parishes the deficiency is not so great, Greenwich being about a fair estimate, and Woolwich somewhat below. The result of the comparison of the Income Tax and Poor Rate Assessments will, he believes, lead to the Assessment Committee bringing up the parishes of Saint Nicholas and Saint Paul, Deptford, and Woolwich, to the proper standard. He at the same time states that he believes the Income Tax Assessment to be in many cases too high.

63. GREAT GRIMSBY.

Population in 1831	6,589	Population in 1861	15,060	Increase	8,471
		Population in 1866 (computed)	16,689	Increase	10,100

Inhabited Houses in 1861 - - - 3,161

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	303	1,012	709	—
Freemen	353	346	—	7
Total	656	1,358	709	7
			Net Increase. 702	

Double entries on Register of 1865-6 :—			
As £10 Occupiers	6	85	Number who voted at the last General Election.
As £10 Occupiers and Freemen	79		
Actual Number of Electors		1,273	1,056

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	215
As Freemen	181
Total	396

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted in two out of the four Parishes.

The Gross Estimated Rental—	£
In 1856 was	41,951
The present Gross Estimated Rental is	60,375
Increase	18,424

The Rateable Value—	£	
In 1856 was	35,438	Increase since 1856 £19,010
In 1862 immediately before the date of the Union Assessment Committee Act it was	39,782	since 1862 £14,666
The present Rateable Value is	54,448	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	70,542
The Gross Estimated Rental of the same description of Property according to the Valuation List is	54,793*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	1,970
£6 and under £7	311
£7 and under £8	178
£8 and under £9	184
£9 and under £10	95
£10 and over	753
	3,491

At a Rateable Value of—	
£4 and under £5 is	953
£5 and under £6	380
£6	127
Above £6 and under £7	140
£7 and under £8	139
£8 and under £9	144
£9 and under £10	98
£10 and over	638

In eight Parishes the Gross Estimated Rental it is stated represents the full rack rent. In the Parish of Great Grimsby it represents the full rack rent as valued by Assessors, but not the actual rent paid by the Tenant, which would be at least 10 per cent. more.

In two Parishes a deduction of 5 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 ; in one Parish 6 per cent.; in three Parishes from 7½ to 10 per cent.; and in one Parish 10 per cent.

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* It is stated that great differences exist between the Gross Estimated Rental and the actual rent.

64. GUILDFORD.

Population in 1851	5,286	Population in 1861	8,020	Increase - 2,734
		Population in 1866 (computed)	8,748	Increase - 3,462

Inhabited Houses in 1861 - - 1,466

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	269	685	425	—
Freeholders		9		
Freemen	73	31	—	42
Total	342	725	425	42
			Net Increase. 383	

Double entries on Register of 1865–6 :—

As £10 Occupiers	19	58	
As £10 Occupiers and Freemen, &c.	39		Number who voted at the last General Election.
Actual Number of Electors		667	581

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	227
As Freemen	5
Total	232
Deduct Double entries	3
Net Number	229*

Number of Burgesses	600
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	42
Number of Burgesses on the Parliamentary Register	511

The Small Tenements Act has been adopted in a majority of the Parishes.

The Gross Estimated Rental—	£
In 1856 was	23,776
The present Gross Estimated Rental is	35,926
Increase	12,150

The Rateable Value—	£	
In 1856 was	19,939	Increase since 1856 £8,977
In 1862 immediately before the date of the Union Assessment Committee Act it was	22,396	since 1862 £6,520
The present Rateable Value is	28,916	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	37,249
The Gross Estimated Rental of the same description of Property according to the Valuation List is	34,171

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	120
£6 and under £7	73
£7 and under £8	116
£8 and under £9	67
£9 and under £10	80
£10 and over	786
	1,242

At a Rateable Value of—	
£4 and under £5 is	77
£5 and under £6	99
£6	96
Above £6 and under £7	48
£7 and under £8	150
£8 and under £9	110
£9 and under £10	70
£10 and over	485

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of about one third is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parishes of the Friary and St. Mary, about one fourth in the Parish of Stoke, and nearly one seventh in the Parishes of Holy Trinity and St. Nicholas (including Artington). There are no Houses in the Parish of Bowling Green at or under £10.

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* It is stated that there is a large coach factory and also two iron foundries in the borough which employ a great many hands. The general condition of the working classes is such as to enable them to reside in £10 houses.

65. HALIFAX.

Population in 1831 - 21,552	Population in 1861 -	37,014	Increase -	15,462
	Population in 1866 (computed) -	38,859	Increase -	17,307

Inhabited Houses in 1861 - - 7,807

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	536	1,788	1,252

Double entries on Register of 1865–6 :—

As £10 Occupiers - - - -	17	No contest at the last General Election.
Actual Number of Electors - -	1,771	

Number of Working Classes on the present Parliamentary Register - - 171

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in two of the three Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was - - -	108,996
The present Gross Estimated Rental is - - - - -	143,456
Increase - -	34,460

The Rateable Value—	£	
In 1856 was - -	82,763	Increase since 1856 £33,296
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	107,977	since 1862 £8,082
The present Rateable Value is - - -	116,059	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	148,894*
The Gross Estimated Rental of the same description of Property according to the Valuation List is	131,227*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	4,269
£6 and under £7 - - -	641
£7 and under £8 - - -	291
£8 and under £9 - - -	250
£9 and under £10 - - -	254
£10 and over - - -	1,988
	7,693

At a Rateable Value of—	
£4 and under £5 is - - -	1,113
£5 and under £6 - - -	401
£6 - - - - - -	92
Above £6 and under £7 - -	298
£7 and under £8 - - -	298
£8 and under £9 - - -	165
£9 and under £10 - - -	116
£10 and over - - - -	1,559

The Gross Estimated Rental is stated to be one tenth less than the full rack rent. A new valuation is in progress which is expected to be more than one sixth above the present valuation.

A deduction of about one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The greater part of the difference between these two amounts is accounted for by the fact that the Gross Estimated Rental is less than the rack rent. The Clerk to the Guardians states, however, that he is informed by the surveyor of taxes that in some instances the Income Tax Assessments are upon profits which exceed the rack rent.

66. HARWICH.

Population in 1831 -	4,297	Population in 1861 -	5,070	Increase -	773
		Population in 1866 (computed) -	5,411	Increase -	1,114

Inhabited Houses in 1861 - - - - 811

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - - -	198	389	191	—
Freemen - - - -	16	—	—	16
Total - - -	214	389	191	16
			Net Increase. 175	

Double entries on Register of 1865–6:— As £10 Occupiers - - - - -	3	Number who voted at the last General Election.
Actual Number of Electors - -	386	306

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - - 125

Number of Burgesses - - - - - - - - - - -	466
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	None.
Number of Burgesses on the Parliamentary Register - - - - - -	326

The Gross Estimated Rental—

	£
In 1856 was - - - - -	12,616
The present Gross Estimated Rental is - - - - - - -	17,625
Increase - - -	5,009

The Rateable Value—

	£	
In 1856 was - - -	10,228	Increase since 1856 £4,056
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	11,430	since 1862 £2,854
The present Rateable Value is - - - - -	14,284	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	17,809
The Gross Estimated Rental of the same description of Property according to the Valuation List is	16,505

The Number of Male Occupiers:—

At a Gross Estimated Rental of—

Under £6 is - - - - - -	144
£6 and under £7 - - - -	43
£7 and under £8 - - - -	20
£8 and under £9 - - - -	23
£9 and under £10 - - - -	24
£10 and over - - - - -	451
	705

At a Rateable Value of—

£4 and under £5 is - - - - -	44
£5 and under £6 - - - - -	36
£6 - - - - - - - - -	19
Above £6 and under £7 - - - -	7
£7 and under £8 - - - -	36
£8 and under £9 - - - - -	100
£9 and under £10 - - - -	46
£10 and over - - - - - -	298

The Clerk to the Guardians states that the Gross Estimated Rental is supposed to represent the full rack rent, but that he does not believe that it does so.

A deduction of from one fourth to one fifth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parish of Dovercourt, and about one fifth in the Parish of St. Nicholas.

67. HASTINGS.

Population in 1831	10,097	Population in 1861	22,910	Increase	12,813
		Population in 1866 (computed)	26,587	Increase	16,490

Inhabited Houses in 1861 - - 3,290

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	1,938	1,938	—
Freemen	20	3	—	17
Scot and Lot Voters	554	—	—	554
Total	574	1,941	1,938	571
			Net Increase. 1,367	

Double entries on Register of 1865–6:—

As £10 Occupiers	68	70	Number who voted at the last General Election.
As £10 Occupiers and Freemen	2		
Actual Number of Electors		1,871	1,438

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - 807*

Number of Burgesses	1,840
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	50
Number of Burgesses on the Parliamentary Register	1,499

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	106,197
The present Gross Estimated Rental is	182,595
Increase	76,398

The Rateable Value—	£	
In 1856 was	86,165	Increase since 1856 £60,359
In 1862 immediately before the date of the Union Assessment Committee Act it was	114,954	since 1862 £31,570
The present Rateable Value is	146,524	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	175,194
The Gross Estimated Rental of the same description of Property according to the Valuation List is	178,379

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	88
£6 and under £7	102
£7 and under £8	126
£8 and under £9	77
£9 and under £10	95
£10 and over	2,269
	2,757

At a Rateable Value of—	
£4 and under £5 is	116
£5 and under £6	59
£6	16
Above £6 and under £7	119
£7 and under £8	135
£8 and under £9	193
£9 and under £10	139
£10 and over	1,955

The Gross Estimated Rental is stated to represent the full rack rent.†

In all the Parishes, with the exception of the Parish of Bexhill in which 15 per cent. is deducted, a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* During the last eight or ten years much building has been going on at Hastings, and it has drawn together a large number of mechanics and others employed in building operations. The rents in the borough are high.

† It is stated that when the Landlord pays the rates instead of the Occupier, about 15 per cent. is the proportion of rent estimated to cover the rates.

68. HELSTON.

Population in 1831	7,115	Population in 1861	8,497	Increase	1,382
		Population in 1866 (computed)	9,150	Increase	2,035

Inhabited Houses in 1861 - - - 1,683

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	281	357	76	—
Freemen	60	6	—	54
Total	341	363	76	54
			Net Increase. 22	

Double entries on Register of 1865-6 :—

As £10 Occupiers	11	15	Number who voted at the last General Election.
As £10 Occupiers and Freemen	4		
Actual Number of Electors		348	298

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - 57

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	16,918
The present Gross Estimated Rental is	22,372
Increase	5,454

The Rateable Value—	£	
In 1856 was	15,060	Increase since 1856 £4,058
In 1862 immediately before the date of the Union Assessment Committee Act it was	14,671	since 1862 £4,447
The present Rateable Value is	19,118	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	24,162
The Gross Estimated Rental of the same description of Property according to the Valuation List is	22,004

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	891
£6 and under £7	56
£7 and under £8	33
£8 and under £9	41
£9 and under £10	23
£10 and over	384
	1,428

At a Rateable Value of—	
£4 and under £5 is	91
£5 and under £6	41
£6	23
Above £6 and under £7	18
£7 and under £8	33
£8 and under £9	40
£9 and under £10	40
£10 and over	315

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction varying from 10 to 35 per cent. according to the nature and condition of the property is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10. The average deduction is 20 per cent. in Helston and Sithney and 15 per cent. in Wendron.

69. HEREFORD.

Population in 1831 - 10,934	Population in 1861	-	15,585	Increase -	4,651
	Population in 1866 (computed)	-	17,682	Increase -	6,748

Inhabited Houses in 1861 - - 3,005

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers - -	459	1,129	670	—
Freemen - - - - -	461	185	—	276
Total - -	920	1,314	670	276
			Net Increase. 394	

Double entries on Register of 1865–6:—

As £10 Occupiers - -	31	99	Number who voted at the last General Election.
As £10 Occupiers and Freemen	68		
Actual Number of Electors - -		1,215	986

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - -	266
As Freemen - - - -	73
Total - - - - - -	339
Deduct Double entries - -	16
Net Number - - - -	323*

Number of Burgesses - - - - - - - - -	1,812
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	552
Number of Burgesses on the Parliamentary Register - - - - - -	943

The Small Tenements Act has been adopted in a majority of the Parishes, but not in the largest and most populous.

The Gross Estimated Rental—	£
In 1856 was - - - - -	54,183
The present Gross Estimated Rental is - - - - - -	76,487
Increase - - - -	22,304

The Rateable Value—	£	
In 1856 was - - -	43,854	Increase since 1856 £18,592
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	52,189	since 1862 £10,257
The present Rateable Value is - - - -	62,446	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	73,186
The Gross Estimated Rental of the same description of Property according to the Valuation List is	71,234

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	441
£6 and under £7 - - - - -	317
£7 and under £8 - - -	253
£8 and under £9 - - - -	163
£9 and under £10 - - -	110
£10 and over - - - -	1,176
	2,460

At a Rateable Value of—	
£4 and under £5 is - - -	352
£5 and under £6 - - -	329
£6 - - - - - - -	146
Above £6 and under £7 - - -	120
£7 and under £8 - - -	126
£8 and under £9 - - - -	194
£9 and under £10 - - - -	82
£10 and over - - - -	916

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6, and 25 per cent. in the case of Houses at and under £6.

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* With reference to the number of the Working Class on the Register it is stated that in the suburbs of the borough within the last few years a large number of houses, a superior class of cottage property, most of which are of the annual value of £10, have been erected, and are chiefly occupied by the better class of working men.

70. HERTFORD.

Population in 1831 - 5,860	Population in 1861	- 6,769	Increase - 909
	Population in 1866 (computed)	- 6,853	Increase - 993

Inhabited Houses in 1861 - - - 1,227

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Decrease.
£10 Occupiers - - -	Qualifications not distinguished.	496	—
Freemen - - -		96	—
Inhabitant Householders -		10	—
Total - -	849	602	247

Double entries on Register of 1865-6:—

As £10 Occupiers - - -	10	59
As £10 Occupiers and Freemen, &c.	49	
Actual Number of Electors - -		543

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - -	158
As Freemen - - - - -	27
Ancient Right Qualifications - - -	8
Total - - - - -	193
Deduct Double entries - -	7
Net Number - - - - -	186

Number of Burgesses - - - - - - - - - - 636

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 148

Number of Burgesses on the Parliamentary Register - - - - - 432

The Small Tenements Act has been adopted in two out of the six Parishes. The number of Burgesses previously was 611.

The Gross Estimated Rental—

	£
In 1856 was - - - - -	24,286
The present Gross Estimated Rental is - - - - - -	33,527
Increase - - - -	9,241

The Rateable Value—

	£	
In 1856 was - - -	18,212	Increase since 1856 £4,960
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	18,393	since 1862 £4,779
The present Rateable Value is - - - -	23,172	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	27,445
The Gross Estimated Rental of the same description of Property according to the Valuation List is	26,593

The Number of Male Occupiers:—

At a Gross Estimated Rental of—

Under £6 is - - - - -	244
£6 and under £7 - - - - -	104
£7 and under £8 - - - -	86
£8 and under £9 - - - - -	73
£9 and under £10 - - - -	42
£10 and over - - - - -	582
	1,131

At a Rateable Value of—

£4 and under £5 is - - - -	165
£5 and under £6 - - - - -	148
£6 - - - - - - -	40
Above £6 and under £7 - - - -	41
£7 and under £8 - - - -	49
£8 and under £9 - - - - -	87
£9 and under £10 - - - -	58
£10 and over - - - - -	402

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £10, and £25 per cent. on Cottages under £10.

71. HONITON.

Population in 1831 - 3,509	Population in 1861	- 3,301	Decrease	-	208
	Population in 1866 (computed)	- 3,240	Decrease	-	269

Inhabited Houses in 1861 - - - 714

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - - -	—	228	228	—
Potwallers - - - -	511	60	—	451
Total - -	511	288	228	451

Net Decrease.
223

Double entries on Register of 1865–6 :—

		Number who voted at the last General Election.
As £10 Occupiers and Potwallers - - - -	21	
Actual Number of Electors - -	267	249

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	69
Potwallers - - - - - -	38
Total - - -	107
Deduct Double entries -	6
Net Number - -	101

Number of Burgesses - - - - - - - -	343
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	146
Number of Burgesses on the Parliamentary Register - - - - -	227

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - - -	13,442
The present Gross Estimated Rental is - - - - - -	12,847
Decrease - - -	595

The Rateable Value—	£	
In 1856 was - - -	9,719	Increase since 1856 £246
In 1862 immediately before the date of the Union Assessment Committee Act it was - - -	9,657	since 1862 £308
The present Rateable Value is - - -	9,965	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	13,626
The Gross Estimated Rental of the same description of Property according to the Valuation List is	12,129

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	238
£6 and under £7 - - -	16
£7 and under £8 - - -	20
£8 and under £9 - - -	12
£9 and under £10 - - -	21
£10 and over - - - - -	254
	561

At a Rateable Value of—	
£4 and under £5 is - - - -	14
£5 and under £6 - - - - -	18
£6 - - - - - - -	2
Above £6 and under £7 - - -	12
£7 and under £8 - - -	34
£8 and under £9 - - -	25
£9 and under £10 - - -	23
£10 and over - - - - -	191

The Gross Estimated Rental is stated to represent the fall rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6, and 33 per cent. in the case of Cottages under £6.

72. HORSHAM.

Population in 1831 - 5,105	Population in 1861	6,747	Increase	1,642
	Population in 1866 (computed)	7,186	Increase	2,081

Inhabited Houses in 1861 - - 1,267

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	250	400	150	—
Burgesses	7	—	—	7
Total	257	400	150	7
			Net Increase. 143	

		Number who voted at the last General Election.
Actual Number of Electors (No Double entries on Register.)	400	323

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - 85

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was	25,135
The present Gross Estimated Rental is	32,097
Increase	6,962

The Rateable Value—	£	
In 1856 was	19,004	Increase since 1856 £7,277
In 1862 immediately before the date of the Union Assessment Committee Act it was	20,027	since 1862 £6,254
The present Rateable Value is	26,281	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	30,414
The Gross Estimated Rental of the same description of Property according to the Valuation List is	30,243

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	487
£6 and under £7	139
£7 and under £8	34
£8 and under £9	46
£9 and under £10	64
£10 and over	405
	1,175

At a Rateable Value of—	
£4 and under £5 is	103
£5 and under £6	156
£6	1
Above £6 and under £7	114
£7 and under £8	27
£8 and under £9	38
£9 and under £10	51
£10 and over	364

The Gross Estimated Rental is stated to represent the full rack rent, except in the case of Houses at £6 and under for which the owners compound.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

73. HUDDERSFIELD.

Population in 1831 - 19,035	Population in 1861	- 34,877	Increase	- 15,842
	Population in 1866 (computed)	- 37,066	Increase	- 18,031

Inhabited Houses in 1861 - - 6,955

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - -	608	2,138	1,530

		Number who voted at the last General Election.
Actual Number of Persons entitled to vote - -	- - 2,138	1,806

(No double entries on Register.)

Number of Working Classes on the present Parliamentary Register - 268

Not a Municipal Borough.

The Gross Estimated Rental—	£
In 1856 was - - - -	120,041
The present Gross Estimated Rental is - - - - -	171,795
Increase - - - -	51,754

The Rateable Value—	£	
In 1856 was - - -	95,362	Increase since 1856 £37,649
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	124,134	since 1862 £8,877
The present Rateable Value is - - -	133,011	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	173,359*
The Gross Estimated Rental of the same description of Property according to the Valuation List is	156,724*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	2,947
£6 and under £7 - - -	709
£7 and under £8 - - -	352
£8 and under £9 - - -	234
At £9 and under £10 - -	164
At £10 and over - - -	2,102†
	6,508

At a Rateable Value of—	
£4 and under £5 is - - -	1,122
£5 and under £6 - - -	622
At £6 - - - -	112
Above £6 and under £7 - -	264
At £7 and under £8 - -	182
At £8 and under £9 - - -	208
At £9 and under £10 - -	135
At £10 and over - - -	1,775

The Gross Estimated Rental is stated to represent the amount at which the property is considered worth to let, the tenant paying his own taxes, and not the full rack rent actually paid.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The difference between these two amounts arises from the Gross Estimated Rental in the Valuation List being based upon an estimate of what property would let for from year to year, the tenant paying his own taxes, whilst the other extends to the rent actually paid. The excess relates almost exclusively to dwelling-house property, which in many instances has from local differences with the ground landlord reached a point not likely to be long maintained.

† As regards the number of persons on the Register as £10 Occupiers being in excess of the Male Occupiers at a Gross Estimated Rental *of £10 it is accounted for* mainly by Occupiers proving before the Revising Barrister an actual payment of £10, although assessed upon a Gross Estimated Rental of somewhat less than that sum.

74. HUNTINGDON.

Population in 1831	5,413	Population in 1861	6,254	Increase	841
		Population in 1866 (computed)	6,272	Increase	859

Inhabited Houses in 1861 - - - 1,285

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers	Qualifications not distinguished.	363	
Freemen		45	
Total	384	408	24

Double entries on Register of 1865–6 :—			
As £10 Occupiers	3	25	No Contest at the last General Election.
As £10 Occupiers and Freemen	22		
Actual Number of Electors		383	

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	12
As Freemen	6
Total	18

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was	24,225
The present Gross Estimated Rental is	34,764
Increase	10,539

The Rateable Value—	£	
In 1856 was	21,241	Increase since 1856 £9,451
In 1862 immediately before the date of the Union Assessment Committee Act it was	22,615	since 1862 £8,077
The present Rateable Value is	30,692	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	32,402
The Gross Estimated Rental of the same description of Property according to the Valuation List is	32,369

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	454
£6 and under £7	128
£7 and under £8	92
£8 and under £9	56
£9 and under £10	31
£10 and over	416
	1,177

At a Rateable Value of—	
£4 and under £5 is	174
£5 and under £6	115
£6	25
Above £6 and under £7	40
£7 and under £8	34
£8 and under £9	47
£9 and under £10	8
£10 and over	383

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £10, and of 20 per cent. in the case of Houses under £10.

75. HYTHE.

Population in 1831 -	8,911	Population in 1861 -	21,367	Increase -	12,456
		Population in 1866 (computed) -	27,222	Increase -	18,311

Inhabited Houses in 1861 - - 2,843

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	418	1,265	847	—
Freemen - - -	51	48	—	3
Total -	469	1,313	847	3
			Net Increase. 844	

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	14	22
As £10 Occupiers and Freemen	8	
Actual Number of Electors - -		1,291

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - -	413
As Freemen - - - -	15
Total - - -	428*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted in several of the Parishes.

The Gross Estimated Rental—	£
In 1856 was - - -	63,387
The present Gross Estimated Rental is - - - - -	91,006
Increase - - -	27,619

The Rateable Value—	£	
In 1856 was - -	54,586	Increase since 1856 £20,122
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	62,239	since 1862 £12,469
The present Rateable Value is - - -	74,708	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	91,783†
The Gross Estimated Rental of the same description of Property according to the Valuation List is	81,945†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	652
£6 and under £7 - - -	272
£7 and under £8 - - -	232
£8 and under £9 - - -	75
£9 and under £10 - - -	139
£10 and over - - - -	1,203‡
	2,573

At a Rateable Value of—	
£4 and under £5 is - - -	256
£5 and under £6 - -	247
£6 - - - - - -	133
Above £6 and under £7 - -	148
£7 and under £8 - - -	128
£8 and under £9 - -	118
£9 and under £10 - - -	80
£10 and over - - -	1,011

The Gross Estimated Rental is stated to represent the full rack rent.

In the several Parishes, with the exception of the Parish of West Hythe in which from £15 to £25 is deducted, a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* In Hythe there are a great many men who, although only journeymen mechanics or labourers, live in a better class of house than in many towns, in consequence of their wives earning a portion of the living by letting rooms in the summer to visitors. The South-Eastern Railway Company also employ a large number of men at high wages.

† The difference between these amounts is accounted for by the fact that the Commissioners of Taxes have the exact Rentals returned to them, whilst the Assessment Committee have generally estimated the Gross Rental.

‡ With reference to the number of Male Occupiers at £10 Gross Estimated Rental (1,203) being less than the number of Electors as £10 Occupiers (1,251), it is stated that on the Register are found persons who have lately died, and some who removed at Michaelmas last.

76. IPSWICH.

Population in 1831	20,201	Population in 1861	37,950	Increase	17,749
		Population in 1866 (computed)	40,750	Increase	20,549

Inhabited Houses in 1861 - - - 8,272

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	875	1,877	1,002
Freemen	344	360	16
Total	1,219	2,237	1,018

Double entries on Register of 1865–6:—			
As £10 Occupiers	74	119	
As £10 Occupiers and Freemen	45		Number who voted at the last General Election.
Actual Number of Electors		2,118	1,839

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	131
As Freemen	216
Total	347
Deduct Double entries	3
Net Number	344

Number of Burgesses	4,297
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	2,130
Number of Burgesses on the Parliamentary Register	1,487

The Small Tenements Act is in force in 16 of the 22 Parishes.

The Gross Estimated Rental—	£
In 1856 was	112,381
The present Gross Estimated Rental is	143,946
Increase	31,565

The Rateable Value—	£	
In 1856 was	87,803	Increase since 1856 £37,794
In 1862 immediately before the date of the Union Assessment Committee Act it was	98,005	since 1862 £27,592
The present Rateable Value is	125,597	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	132,869
The Gross Estimated Rental of the same description of Property according to the Valuation List is	133,211

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	2,522
£6 and under £7	1,669
£7 and under £8	530
£8 and under £9	135
£9 and under £10	124
£10 and over	2,260*
	7,240

At a Rateable Value of—	
£4 and under £5 is	780
£5 and under £6	1,413
£6	688
Above £6 and under £7	356
£7 and under £8	147
£8 and under £9	266
£9 and under £10	169
£10 and over	1,896

The Gross Estimated Rental is stated to represent the full rack rent.

In 20 of the Parishes comprised in the Borough a deduction of from 10 to 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, in the Parish of Bramford from 10 to 20 per cent. is deducted, in the Parish of Rushmere 25 per cent., and in the Parish of Sproughton "a sum not exceeding 30 per cent." is deducted.

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* When the rates are paid by the Owner instead of the Occupier under the Small Tenements Act 20 per cent. is reckoned as the proportion of the rent which covers the rates, &c.

77. SAINT IVES.

Population in 1831 -	7,115	Population in 1861 -	10,353	Increase -	3,238
		Population in 1866 (computed) -	10,602	Increase -	3,487

Inhabited Houses in 1861 - - 2,116

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	139	448	309	—
Scot and Lot Voters - -	454	88	—	366
Total - -	593	536	309	366
			Net Decrease. 57	

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	6	50	Number who voted at the last General Election.
As £10 Occupiers and Scot and Lot Voters - - -	44		
Actual Number of Electors - -		486	410

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - -	189
As Scot and Lot Voters - -	59
	248

The Parliamentary and Municipal Boundaries are not conterminous.

The Gross Estimated Rental—	£
In 1856 was - - - - -	22,512
The present Gross Estimated Rental is - - - - -	26,412
Increase - - -	3,900

The Rateable Value—	£	
In 1856 was - -	18,923	Increase since 1856 £3,223
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	19,440	since 1862 £2,706
The present Rateable Value is - - -	22,146	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	24,693
The Gross Estimated Rental of the same description of Property according to the Valuation List is	25,132

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	1,144
£6 and under £7 - - - -	117
£7 and under £8 - - -	75
£8 and under £9 - - - - -	63
£9 and under £10 - - -	28
£10 and over - - - -	545
	1,972

At a Rateable Value of—	
£4 and under £5 is - - -	118
£5 and under £6 - - -	84
£6 - - - - - -	7
Above £6 and under £7 - - -	55
£7 and under £8 - - -	33
£8 and under £9 - - - -	152
£9 and under £10 - - -	33
£10 and over - - - -	347

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £6, and 20 per cent. above £6.

78 KENDAL.

Population in 1831	11,577	Population in 1861	12,029	Increase	452
		Population in 1866 (computed)	12,130	Increase	553

Inhabited Houses in 1861 - - - 2,590

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	327	454	127

Double entries on Register of 1865–6 :—

As £10 Occupiers - - - - -	15	No Contest at the last General Election.
Actual Number of Electors - - -	439	

Number of Working Classes on the present Parliamentary Register - - 31*

Number of Burgesses - - - - - - - - -	1,579
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	1,049
Number of Burgesses on the Parliamentary Register - - - -	427

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - -	33,721
The present Gross Estimated Rental is - - - -	42,886
Increase - - -	9,165

The Rateable Value—	£	
In 1856 was - -	29,340	Increase since 1856 £7,101
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	31,512	
The present Rateable Value is - - - -	36,441	since 1862 £4,929

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	35,627†
The Gross Estimated Rental of the same description of Property according to the Valuation List is -	36,313†

The Number of Male Occupiers :—

At a Gross Estimated Rental—	
Under £6 is - - - -	1,533
£6 and under £7 - - -	90
£7 and under £8 - - - -	60
£8 and under £9 - - -	58
£9 and under £10 - - -	27
£10 and over - - - -	466
	2,234

At a Rateable Value of—	
£4 and under £5 is - - -	219
£5 and under £6 - - -	88
£6 - - - - -	40
Above £6 and under £7 - -	57
£7 and under £8 - - -	37
£8 and under £9 - - -	57
£9 and under £10 - - -	34
£10 and over - - -	391

The Gross Estimated Rental is stated to represent the full rack rent, except when Houses at or under £6 are compounded for.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the small number of the working classes on the Register it is stated that in Kendal a very good house suitable for the residence of a respectable tradesman can be obtained at a rental of £10; the majority of the working classes only occupy houses of a rental of from 1*s.* per week to £7 or £8 per annum.

† With reference to the difference between the two assessments it is stated that the Income Tax Assessment was made in April, whereas the Gross Estimated Rental is taken from the Valuation Lists now in force, and the amount since April has been increased by Supplemental Lists.

79. KIDDERMINSTER.

Population in 1831	16,000	Population in 1861	15,399	Decrease	601
		Population in 1866 (computed)	14,064	Decrease	1,936

Inhabited Houses in 1861 - - 3,354

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.
£10 Occupiers	390	625	235

		Number who voted at the last General Election.
Double Entries on Register of 1865-6	13	
Actual Number of Electors	612	555

Number of Working Classes on the present Parliamentary Register - 104

Number of Burgesses - - - - - - 1,497

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 923

Number of Burgesses on the Parliamentary Register - - - 574

There is a Local Act for each of the two Parishes authorizing the rating of Owners. The limit of Rateable Value in one case is under £10, in the other under £7.*

The Gross Estimated Rental—	£
In 1856 was	41,394
The present Gross Estimated Rental is	46,519
Increase	5,125

The Rateable Value—	£	
In 1856 was	38,991	Decrease since 1856 £1,765
In 1862 immediately before the date of the Union Assessment Committee Act it was	35,084	Increase since 1862 £2,142
The present Rateable Value is	37,226	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	47,197
The Gross Estimated Rental of the same description of Property according to the Poor Rate is	44,254

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	1,941
£6 and under £7	293
£7 and under £8	84
£8 and under £9	43
£9 and under £10	6
£10 and over	726
	3,093

At a Rateable Value of—	
£4 and under £5 is	717
£5 and under £6	99
£6	1
Above £6 and under £7	21
£7 and under £8	28
£8 and under £9	192
£9 and under £10	35
£10 and over	524

The Gross Estimated Rental it is stated as a rule represents the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses under £8, and 15 per cent. Houses at and above £8.

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* The first Act 4 & 5 Vict. c. 72. provides that nothing contained in it should prejudice or affect any Municipal or Parochial Franchises to which the occupier of any dwelling house would by law be then entitled, but that such occupier should and might claim to be put upon the burgess list, and use and exercise any such Franchises in the same manner to all intents and purposes as he might or could have done before the passing of the Act, or if he had been rated and assessed in his own name.

80. KINGS LYNN.

Population in 1831	13,370	Population in 1861	16,170	Increase	2,800
		Population in 1866 (computed)	14,780	Increase	1,410

Inhabited Houses in 1861 - - - - 3,637

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	583	805	222	—
Freemen or Free Burgesses	253	96	—	157
Total	836	901	222	157
			Net Increase. 65	

Double entries on Register of 1865–6 :—			
As £10 Occupiers	12	49	Number who voted at the last General Election
As £10 Occupiers and Freemen	37		
Actual Number of Electors		852	749

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	127
As Freemen	26
Total	153
Deduct double entry	1
Net Number	152

Number of Burgesses	1,142
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	None
Number of Burgesses on the Parliamentary Register	713

There is a Local Act 48 Geo. 3. c. 22. authorizing the rating of Owners, the limit of the Rateable Value being £8.

The Gross Estimated Rental—	£
In 1856 was	56,733
The present Gross Estimated Rental is	56,556
Decrease	177

The Rateable Value—	£	
In 1856 was	39,826	Increase since 1856 £768
In 1862 immediately before the date of the Union Assessment Committee Act it was	38,591	since 1862 £2,003
The present Rateable Value is	40,594	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	58,560*
The Gross Estimated Rental of the same description of Property according to the Valuation List or Poor Rate is	53,963*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	762
£6 and under £7	191
£7 and under £8	105
£8 and under £9	142
£9 and under £10	72
£10 and over	867
	2,139

At a Rateable Value of—	
£4 and under £5 is	380
£5 and under £6	213
£6	8
Above £6 and under £7	84
£7 and under £8	173
£8 and under £9	101
£9 and under £10	110
£10 and over	535

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 30 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The explanation offered of the difference between the two assessments is that a large number of small houses are let on the terms of the landlord paying all rates and outgoings. For these allowance is made in the Poor Rate but not in the Income Tax Assessment.

81. KINGSTON-UPON-HULL.

Population in 1831	51,911	Population in 1861	97,661	Increase	45,750
		Population in 1866 (computed)	104,873	Increase	52,962

Inhabited Houses in 1861 - - - - 19,516

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	2,664	5,140	2,476	—
Freemen	1,656	1,358	—	298
Total	4,320	6,498	2,476	298
			Net Increase. 2,178	

Double entries on Register of 1865–6:—

As £10 Occupiers	269	932	Number who voted at the last General Election.
As £10 Occupiers and Freemen	663		
Actual Number of Electors		5,566	4,671

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	660
As Freemen	349
Total	1,009
Deduct double entries	91
Net number	918

Number of Burgesses	7,505
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	1,769
Number of Burgesses on the Parliamentary Register	4,547

A Local Act, 5 Geo. 4. c. 13., is in force in the Parishes of Holy Trinity and St. Mary, and another Local Act, 4 Will. 4. c. 5., is in force in the Parish of Sculcoates; in each case the rating limit is under £10 yearly rent or value, except where Houses are let to weekly or monthly tenants, or in separate apartments.

The Gross Estimated Rental—	£	**The Rateable Value**—	£	
In 1856 was	291,533	In 1856 was	225,361	Increase since 1856
The present Gross Estimated Rental is	401,934	The present Rateable Value is	307,153	£81,792
Increase	110,401			

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	376,262
The Gross Estimated Rental of the same description of Property according to the Valuation List is	343,345

The Number of Male Occupiers:—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	5,124	£4 and under £5 is	3,552
£6 and under £7	2,494	£5 and under £6	2,156
£7 and under £8	1,740	£6	1,853
£8 and under £9	1,734	Above £6 and under £7	14
£9 and under £10	998	£7 and under £8	765
£10 and over	7,119*	£8 and under £9	846
		£9 and under £10	432
	19,209	£10 and over	4,960

The Gross Estimated Rental is stated to represent the full rack rent.

In the United Parishes of Holy Trinity and St. Mary, Hull, one third and one fifth are deducted from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, which are compounded for. In the other Parishes about 20 per cent. is deducted.

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* The difference between the number of Male Occupiers at a Gross Estimated Rental of £10 and the number of Electors on the Register as £10 Occupiers it is stated is attributable to the rapid changes of occupancy in a mercantile town, and to the fact that upwards of 1,000 new houses are built and occupied in the year, the Occupiers of which would not come on the Register of July.

Amongst the male occupations at £10 and upwards Gross Estimated Rental in the parishes of Holy Trinity and St. Mary, 1,164 are stated to be compounded for. In these cases the Gross Estimated Rental includes the additional amount paid by the tenant to the landlord to cover the tenant's rates and taxes. This estimated additional amount for compounded houses at and over £10 is £2 per annum; for houses at £9 and under £10, £1 10*s.*; and for houses at £8 and under £9, £1.

There is one building let out in model lodgings.

82. KNARESBOROUGH.

Population in 1831	5,936	Population in 1861	5,402	Decrease	534
		Population in 1866 (computed)	5,336	Decrease	600

Inhabited Houses in 1861 - - - 1,318

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers	278	290	12

Double entries on Register of 1865–6 :—

		Number who voted at the last General Election.
As £10 Occupiers	18	
Actual Number of Electors	272	247

Number of Working Classes on the present Parliamentary Register - - 20

The Small Tenements Act does not appear to have been adopted.

The Gross Estimated Rental—	£
In 1856 was	12,766
The present Gross Estimated Rental is	13,831
Increase	1,065

The Rateable Value—	£	
In 1856 was	9,548	Increase since 1856 £1,014
The present Rateable Value is	10,562	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	14,087
The Gross Estimated Rental of the same description of Property according to the Valuation List is	13,676

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	620
£6 and under £7	51
£7 and under £8	28
£8 and under £9	23
£9 and under £10	9
£10 and over	314
	1,045

At a Rateable Value of—	
£4 and under £5 is	61
£5 and under £6	26
£6	18
Above £6 and under £7	14
£7 and under £8	55
£8 and under £9	8
£9 and under £10	46
£10 and over	210

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

83. LAMBETH.

Population in 1831 154,613 { Population in 1861 - 294,883 Increase - 140,270
Population in 1866 (computed) } - 319,403 Increase - 164,790

Inhabited Houses in 1861 - - 44,529

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - - -	4,768	27,754	22,986

Actual Number of Electors - - - - 27,754
(No Double entries on Register.)

Number of Votes recorded at the last General Election. 17,910

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - - 9,501*

Local Acts for rating Owners instead of Occupiers are in force in the following Parishes:—

Camberwell, St. Giles. 3 Will. 4. c. 33., with a rating limit of £20 yearly rent or value, except where Houses are let to weekly or monthly tenants, or at rents payable at any shorter period than quarterly, or let furnished or in separate apartments.

Lambeth. 50 Geo. 3. c. 19, with a rating limit of under £20 yearly rent or value, except where Houses are let at rents payable at any shorter period than quarterly, or let either wholly or partly in lodgings or separate apartments.

Newington, St. Mary. 54 Geo. 3. c. 113., with a rating limit of £20 yearly rent or value, except where Houses are let to weekly or monthly tenants, or let in separate apartments at rents payable at any shorter period than quarterly.

The Gross Estimated Rental—

	£
In 1856 was - - - - -	1,060,410
The present Gross Estimated Rental is	1,360,708
Increase - - - -	300,298

The Rateable Value—

	£
In 1856 was - - -	854,781
The present Rateable Value is - - -	1,023,871

Increase since 1856 £169,090.

The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - - £ 1,438,161

The Gross Estimated Rental of the same description of Property according to the Valuation List is 1,307,635

The Number of Male Occupiers:—

Parish.	Gross Estimated Rental of								Rateable Value of							
	Under £4.	£4 and under £5.	£5 and under £6.	£6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.	£4 and under £5.	£5 and under £6.	£6.	Above £6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.
Lambeth - -	5	12	40	130	220	57	414	18,815	116	272	351	72	879	825	440	16,920
Camberwell, St. Giles -	48	59	123	416	431	351	620	9,837	122	207	273	384	340	631	541	9,296
Newington, St. Mary -	—	15	18	279	85	736	165	9,891	1,298	1,027	808	106	967	979	629	5,534
TOTAL - -	53	86	181	825	736	1,144	1,199	38,543	1,536	1,506	1,432	562	2,186	2,435	1,610	31,750

Lambeth Parish.—The Gross Estimated Rental represents the full rack rent, the tenants paying rates, &c., except in cases of farmed property, when it is the actual rent paid; the Landlord discharging the tenant's rates. In arriving at the Rateable Value one sixth is allowed from the Gross Estimated Rental, excepting when the property is farmed, when one third of the Gross Rental is allowed. The true Rateable Value, and not the composition in respect of which the Landlord is charged, is entered as the Rateable Value.

There are 9,879 tenements at and above £10 Gross Estimated Rental rated to the Owners instead of the Occupiers. 5,781 Compound Occupiers are on the Parliamentary Register.

There are 97 houses in the parish above the Rateable Value of £10 let out in distinct tenements. A considerable number are lodging-houses. In 11 of these houses the number of those separate lettings is as follows:—28 at and above £10, 13 at £8 and under £10, and 10 at £5 and under £8.

St. Giles, Camberwell, Parish.—The Gross Estimated Rental represents the full rack rent. A deduction equal to 34 per cent. is allowed in arriving at the Rateable Value of houses at and under £10. These houses are, however, compounded for by the Owners, and the weekly rental of the property is taken as the standard in pounds sterling for its compound value; thus a house of the weekly rental of 3*s*. would be assessed to the Owner at £3 per annum.

4,921 tenements at and above £10 rental are rated to the Owners instead of the Occupiers. There are at present only five of such Occupiers on the Register.

There are no houses in the parish let out in distinct tenements.

St. Mary, Newington, Parish.—The Gross Estimated Rental, except in the case of compounded houses, represents the full rack rent. The rule, with regard to compounded houses, in estimating the Gross Rental, is to deduct 20 per cent. from the rack rent paid by the tenant to the Landlord. Upon this reduced amount the Rateable Value is based, and is made by a further deduction of 50 per cent., so that in the case of a £10 house the Rateable Value in respect of which the Landlord would be charged would be £4.

There are upwards of 6,800 houses in the parish for which the Owners are rated. Of those 5,550 are of an annual value to give a vote for the borough, and of that number 4,360 are tenanted by Male Occupiers who are placed on the Parliamentary Register.

There are 159 houses in the parish at and above £5 Rateable Value let out in distinct tenements. In no instance has an Occupier of a distinct tenement claimed to be rated and afterwards been placed on the Register.

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* It is stated that in Newington parish a staff of persons were employed to call at all the houses in the parish, the names of the Occupiers of which are on the Register, where the calling of the residents was unknown, and that special care was exercised in eliciting the exact number of persons supporting themselves by daily manual labour.

84. LANCASTER.

Population in 1831	14,066	Population in 1861	16,005	Increase	1,939
		Population in 1866 (computed)	15,924	Increase	1,858

Inhabited Houses in 1861 - - 2,992

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	261	467	206
Freemen	848	1,006	158
Total	1,109	1,473	364

Double entries on Register of 1865–6:—			
As £10 Occupiers	3	8	Number who voted at the last General Election.
As £10 Occupiers and Freemen	5		
Actual Number of Electors		1,465	1,339

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	57
As Freemen	608
Total	665
Double entries	2
Net Number	663

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted in two out of the three Parishes.

The Gross Estimated Rental—	£
In 1856 was	50,435
The present Gross Estimated Rental is	56,285
Increase	5,850

The Rateable Value—	£	
In 1856 was	44,289	Increase, since 1856 £3,865
In 1862 immediately before the date of the Union Assessment Committee Act it was	46,249	since 1862 £1,905
The present Rateable Value is	48,154	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	55,880*
The Gross Estimated Rental of the same description of Property according to the Valuation Lists is	51,854*

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	956
£6 and under £7	366
£7 and under £8	300
£8 and under £9	207
£9 and under £10	89
£10 and over	754†
	2,672

At a Rateable Value of—	
£4 and under £5 is	485
£5 and under £6	355
£6	138
Above £6 and under 7	261
£7 and under £8	169
£8 and under £9	108
£9 and under £10	52
£10 and over	599

The Gross Estimated Rental is stated to represent the full rack rent.

With a few exceptions, a deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and above £6, and 20 per cent. in the case of Houses under £6.

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* With reference to the difference between these amounts it is explained that several properties exempt from rates by reason of their use for public purposes, such as buildings connected with a County Lunatic Asylum, Judges Lodgings, are included in Schedule A. In consequence of the cotton distress the value of several mills was reduced, but no alteration has been made in the Income Tax Assessment. A new mill and some other property is inserted in Schedule A. which had not at the time of the Return come into the Valuation List.

† With reference to the difference between the number of Male Occupiers at £10 Gross Estimated Rental and the number of persons on the Register as £10 Occupiers, it is stated that those on the Register as Freemen have not been inserted in the Occupiers' List, except in a few cases in which it has been done inadvertently.

85. LAUNCESTON.

Population in 1831	5,414	Population in 1861	5,140	Decrease	274
		Population in 1866 (computed)	4,755	Decrease	659

Inhabited Houses in 1861 - - 1,020

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	231	421	190	—
Freemen	12	—	—	12
Total	243	421	190	12
			Net Increase. 178	

Double entries on Register of 1865–6:—

As £10 Occupiers	50
Actual Number of Electors	371

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	82
Deduct Double entries	4
Net Number	78*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act does not appear to have been adopted.

The Gross Estimated Rental—	£
In 1856 was	23,714
The present Gross Estimated Rental is	27,688
Increase	3,974

The Rateable Value—	£	
In 1856 was	19,726	Increase since 1856 £4,021
In 1862 immediately before the date of the Union Assessment Committee Act it was	17,918	since 1862 £5,829
The present Rateable Value is	23,747	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	28,998
The Gross Estimated Rental of the same description of Property according to the Valuation List is	27,298

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	398
£6 and under £7	34
£7 and under £8	11
£8 and under £9	24
£9 and under £10	11
£10 and over	355†
	833

At a Rateable Value of—	
£4 and under £5 is	42
£5 and under £6	19
£6	16
Above £6 and under £7	9
£7 and under £8	21
£8 and under £9	16
£9 and under £10	23
£10 and over	301

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of about 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, with variations according to the state of repair, &c.

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* The large number of the Working Class on the Register is attributed to the fact that there is a custom prevailing chiefly in the parish of St. Stephen of allowing labourers to occupy a field or two, which gives them the Franchise.

† With refesence to the number of Electors on the Register as £10 Occupiers being in excess of the Male Occupiers at £10 Gross Estimated Rental, it is stated as follows:—There are persons on the Register who are rated for land only, and others whose Gross Estimated Rental is as low as £5 5*s*. In some portions of the borough the rents and probably the sums in the Valuation List are very low, and on the other hand there can be no doubt that there are persons on the Register who should not be there, some of them having been removed on objection being made before the Revising Barrister, and restored by the Overseers without any alterations in their tenancies, and these have been allowed to pass from the fact that no opposition was offered on the last revision of voters.

86. LEEDS.

Population in 1831 - 123,393	Population in 1861	- 207,165	Increase	- 83,772
	Population in 1866 (computed)	- 227,180	Increase	- 103,787

Inhabited Houses in 1861 - - 44,651

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	Above 4,000	8,485	4,485

Double entries on Register of 1865–6 :—

		Number who voted at the last General Election.
As £10 Occupiers - - - - -	1,268	
Actual Number of Electors - -	7,217	6,088

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - 523

Number of Burgesses - - - - - - - - - - 32,877

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 18,465

Number of Burgesses on the Parliamentary Register - - - - 6,066

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was - - - -	548,198
The present Gross Estimated Rental is - - - - -	743,067
Increase - - -	194,869

The Rateable Value—	£	
In 1856 was - -	457,792	Increase since 1856 £127,691
The present Rateable Value is - - -	585,483	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	765,196*
The Gross Estimated Rental of the same description of Property according to the Valuation List or Poor Rate is - - - - - - - - - - -	718,010*

The Number of Male Occupiers :—†

At a Gross Estimated Rental of—	
Under £6 is - - - -	26,855
£6 and under £7 - - -	4,171
£7 and under £8 - - -	2,216
£8 and under £9 - - - -	1,072
£9 and under £10 - - -	664
£10 and over - - - -	9,337
	44,315

At a Rateable Value of—	
£4 and under £5 is - - -	8,412
£5 and under £6 - - - -	4,670
£6 - - - - -	1,542
Above £6 and under £7 - - -	1,243
£7 and under £8 - - - -	972
£8 and under £9 - - - -	1,220
£9 and under £10 - - -	426
£10 and over - - - -	7,960

The Gross Estimated Rental is stated to represent the full rack rent in Leeds, Holbeck, Templenewsam, Bramley, Chapel Allerton, Potter Newton, Seacroft, and Farnley. In Wortley it is considered a fair representation of the full rack rent. In Beeston and Armley it is one third, in Hunslet one sixth, and in Headingley-cum-Burley one eighth, less than the rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Townships of Holbeck, Templenewsam, Leeds, Bramley, Beeston, Chapel Allerton, Potter Newton, Wortley, Farnley, and Hunslet; from one third to one sixth in the Township of Armley; and in the Township of Headingley-cum-Burley one sixth for Houses above £8 5*s*., and 50 per cent. for Houses under £8 5*s*., which are compounded for. There are no Houses of the class referred to in the Township of Seacroft.

In Leeds where the owner pays rates the proportion paid for rates out of the amount received by the owner for rent and rates together is about 3*s*. 7*d*. in the pound on the gross amount he receives.

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* With reference to the difference between these amounts it is stated that all the small tenements in the Borough are classed under Schedule A. at the full rack rent, less the amount of tenant's rates actually paid by the Landlord; whereas in cases where the rates on tenements are compounded for, the Gross Estimated Rental in the Poor Rate is the value of the Property after the deduction of all tenant's rates estimated, but not actually paid thereon by the Landlord. Also many religious, charitable, literary, scientific, and other institutions which are assessed to the Income Tax are omitted from the Poor Rate Assessment.

† In Leeds township all premises that are let out in separate apartments are rated to the several separate Occupiers, the tenants, names appear in the Poor Rate, and are included in the Return of Male Occupiers.

87. LEICESTER.

Population in 1831 - 40,639	Population in 1861 -	68,056	Increase - 27,417
	Population in 1866 (computed)	72,131	Increase - 31,492

Inhabited Houses in 1861 - - 14,595

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	1,200	3,588	2,388	—
Freemen - - -	2,070	1,839	—	231
Scot and Lot Voters - -	256	11	—	245
Total - -	3,526	5,438	2,388	476
			Net Increase. 1,912	

Double entries on Register of 1865–6:—			
As £10 Occupiers - -	240	676	
As £10 Occupiers and Freemen or Scot and Lot Voters -	436		Number who voted at the last General Election.
Actual Number of Electors - -		4,762	4,121

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - -	651
As Freemen - - - - -	1,273
As Scot and Lot Voters - -	2
Total - - -	1,926
Double entries - -	27
Net Number - -	1,899*

Number of Burgesses - - - - - - - - - -	4,986
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	2,120
Number on the Parliamentary Register - - - - - - -	2,957

The Small Tenements Act has been partially adopted.
In the largest Parish, St. Margaret's, there is a Local Compounding Act.
The Number before the partial adoption of the Small Tenements Act was 2,348.

The Gross Estimated Rental—	£
In 1856 was - - - -	174,181
The present Gross Estimated Rental is - - - - -	263,424
Increase - - - -	89,243

The Rateable Value—	£	
In 1856 was - -	130,142	Increase since 1856 £70,914
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	158,957	since 1862 £42,099
The present Rateable Value is - - -	201,056	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	236,312
The Gross Estimated Rental of the same description of Property according to the Valuation List is	244,866

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - -	3,858
£6 and under £7 - - -	2,958
£7 and under £8 - - -	1,696
£8 and under £9 - - -	752
£9 and under £10 - - -	494
£10 and over - - -	4,369†
	14,127

At a Rateable Value of—	
£4 and under £5 is - - -	2,219
£5 and under £6 - - -	3,449
£6 - - - - -	81
Above £6 and under £7 - - -	843
£7 and under £8 - - -	1,018
£8 and under £9 - - -	294
£9 and under £10 - - -	567
£10 and over - - - -	2,935

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one fourth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the large number of the Working Classes on the Register it is stated that there is an extensive tract of land belonging to the Freemen, a part of which is allotted in gardens, and over the other part of which they have a right of common. The desire to possess land is very general, and no sooner does a young man entitled to the freedom of the borough attain his majority than he at once takes up his freedom. However numerous may be his family, all the males are like himself Freemen. In many of the trades also the workmen earn large wages, whereby if they are prudent men they are soon enabled to remove to a better house, or, what not unfrequently happens, become the owners of one through a building society.

† As regards the difference between the number of £10 Occupiers on the Register and the number of Male Occupiers at £10 Gross Estimated Rental it is stated that since July 1864 when to confer the franchise £10 houses must have been on the Rate Book hundreds of new houses have been erected, the majority of which are of a value of £10 and upwards. Since Midsummer last also there has been a new Valuation List, and rents having largely increased in consequence of the prosperous state of the town an addition of at least £8,000 has been made to the Gross Estimated Rental, the greatest increase being on houses from £8 to £12 in value. This advance being made at Midsummer last, the Occupiers would only get on the Register in the few instances in which claims were made.

88. LEOMINSTER.

Population in 1831 - 5,249	Population in 1861	5,658	Increase	409
	Population in 1866 (computed)	5,894	Increase	645

Inhabited Houses in 1861 - - 1,157

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	—	352	352	—
Capital Burgesses	23	4	—	19
Scot and Lot Voters	756	52	—	704
Total	779	408	352	723
			Net Decrease. 371	

Double entries on Register of 1865-6 :—

As £10 Occupiers	15	41	
As £10 Occupiers and Scot and Lot Voters, &c.,	26		Number who voted at the last General Election.
Actual Number of Electors		367	312

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	47
As Scot and Lot Voters, &c	24
Total	71*

Number of Burgesses	563
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	232
Number of Burgesses on the Parliamentary Register	363

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was	26,895
The present Gross Estimated Rental is	38,692
Increase	11,797

The Rateable Value—	£	
In 1856 was	22,714	Increase since 1856 £5,709
In 1862 immediately before the date of the Union Assessment Committee Act it was	22,945	since 1862 £5,478
The present Rateable Value is	28,423	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	32,592†
The Gross Estimated Rental of the same description of Property according to the Valuation List is	30,852

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	421
£6 and under £7	78
£7 and under £8	45
£8 and under £9	35
£9 and under £10	13
£10 and over	399
	991

At a Rateable Value of—	
£4 and under £5 is	90
£5 and under £6	15
£6	29
Above £6 and under £7	40
£7 and under £8	14
£8 and under £9	39
£9 and under £10	19
£10 and over	330

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses from £6 to £10, and 25 per cent. on Houses under £6.

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* It is stated with reference to the number of masons and carpenters included in the Return that there is only one person who keeps a number of men in his employ, and that the public are obliged to rely on jobbing masons, &c. The bakers included are persons who convert into bread flour sent them to be prepared and baked, they charging a certain amount for their trouble. The labourers and farmers are occupiers of small plots of ground which are barely sufficient to find them employment on an average for one day in the week, the remainder of their time being spent in working for the neighbouring farmers as day labourers.

† The Income Tax Assessment it is stated is based on the Valuation Lists of 1863, and the Poor Rate Assessment on the Valuation Lists of 1865.

89. LEWES.

Population in 1831	9,027	Population in 1861	9,716	Increase	689
		Population in 1866 (computed)	9,809	Increase	782

Inhabited Houses in 1861 - - 1,820

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	188	664	476	—
Scot and Lot Voters	690	56	—	634
Total	878	720	476	634
			Net Decrease. 158	

Double entries on Register of 1865-6:—

			Number who voted at the last General Election.
As £10 Occupiers	14	44	
As £10 Occupiers and Scot and Lot Voters	30		
Actual Number of Electors		676	604

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	167
As Scot and Lot Voters	22
Total	189
Deduct Double entries	3
Net Number	186

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	34,612
The present Gross Estimated Rental is	38,373
Increase	3,761

The Rateable Value—	£	
In 1856 was	29,667	Increase since 1856 £2,353
In 1862 immediately before the date of the Union Assessment Committee Act it was	28,970	since 1862 £3,050
The present Rateable Value is	32,020	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	40,189
The Gross Estimated Rental of the same description of Property according to the Valuation List is	36,175

The Number of Male Occupiers:—

At a Gross Estimated Rental—	
Under £6 is	317
£6 and under £7	245
£7 and under £8	141
£8 and under £9	106
£9 and under £10	54
£10 and over	778
	1,641

At a Rateable Value of—	
£4 and under £5 is	182
£5 and under £6	343
£6	24
Above £6 and under £7	57
£7 and under £8	128
£8 and under £9	123
£9 and under £10	77
£10 and over	561

The Gross Estimated Rental is stated to represent the full rack rent.

The following deduction is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, viz.:—

Brick and flint built	£15 per cent.
Do. do. (painted) Mathematical, tiled, or plastered	20 „
Brick and timber built	25 „

90. LICHFIELD.

Population in 1831	6,499	Population in 1861	6,893	Increase	394
		Population in 1866 (computed)	6,834	Increase	335

Inhabited Houses in 1861 - - 1,456

Number of Electors on Parliamentary Register:—

	1832–3.		1865–6.	Increase.	Decrease.
£10 Occupiers	563		414	—	149
Freemen, Freeholders, &c.	298	Freemen	95	8	—
		Freeholders or Burgage Holders	211		
Total	861		720	8	149
				Net Decrease. 141	

Double entries on Register of 1865–6:—

As £10 Occupiers	17	156	Actual Number of Votes recorded at the last General Election.
As £10 Occupiers and Freemen, or Voters in respect of Ancient Right Qualifications	139		
Actual Number of Electors		564	768

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	121
As Freemen	55
As Ancient Right Qualifications	30
Total	206
Deduct Double entries	33
Net Number	173*

Number of Burgesses - - - - - - - - 893

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 455

Number of Burgesses on the Parliamentary Register - - - - 438

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	27,700
The present Gross Estimated Rental is	29,872
Increase	2,172

The Rateable Value —	£	
In 1856 was	24,117	Increase since 1856 £906
In 1862 immediately before the date of the Union Assessment Committee Act it was	24,063	since 1862 £960
The present Rateable Value is	25,023	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	28,442
The Gross Estimated Rental of the same description of Property according to the Valuation List is	28,330

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	539
£6 and under £7	200
£7 and under £8	119
£8 and under £9	45
£9 and under £10	45
£10 and over	384
	1,332

At a Rateable Value of—	
£4 and under £5 is	217
£5 and under £6	178
£6	23
Above £6 and under £7	35
£7 and under £8	39
£8 and under £9	55
£9 and under £10	36
£10 and over	314

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The large number of persons of the Working Class on the Register is attributed to the existence of a coach manufactory, and to their being several very large market gardeners who employ throughout the year many hands.

91. LINCOLN.

Population in 1831	11,217	Population in 1861	20,999	Increase	9,782
		Population in 1866 (computed)	22,979	Increase	11,762

Inhabited Houses in 1861 - - 4,315

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	461	1,267	806	—
Freemen	582	546	—	36
Total	1,043	1,813	806	36

Net Increase. 770

Double entries on Register of 1865–6 :—

As £10 Occupiers	49	100	Number who voted at the last General Election.
As £10 Occupiers and Freemen	51		
Actual Number of Electors		1,713	1,554

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	431
As Freemen	357
Total	788
Deduct Double entries	16
Net Number	772*

Number of Burgesses	2,865
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	1,816
Number of Burgesses on the Parliamentary Register	1,152

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	63,273
The present Gross Estimated Rental is	87,854
Increase	24,581

The Rateable Value—	£	
In 1856 was	52,637	Increase since 1856 £18,246
In 1862 immediately before the date of the Union Assessment Committee Act it was	62,139	since 1862 £8,744
The present Rateable Value is	70,883	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	86,826
The Gross Estimated Rental of the same description of Property according to the Valuation List is	83,767

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	1,010
£6 and under £7	760
£7 and under £8	570
£8 and under £9	271
£9 and under £10	157
£10 and over	1,294
	4,062

At a Rateable Value of—	
£4 and under £5 is	1,016
£5 and under £6	618
£6	182
Above £6 and under £7	277
£7 and under £8	180
£8 and under £9	308
£9 and under £10	124
£10 and over	916

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the number of the Working Classes on the Register it is stated that there are several iron foundries in Lincoln in which a great number of Electors are employed.

92. LISKEARD.

Population in 1831 -	4,094	Population in 1861 -	6,585	Increase -	2,491
		Population in 1866 (computed) -	6,784	Increase -	2,690

Inhabited Houses in 1861 - - 1,146

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	195	450	255	—
Freemen - - - -	23	—	—	23
Total - -	218	450	255	23
			Net Increase. 232	

Double entries on Register of 1865–6:—

As £10 Occupiers - - - -	16	No Contest at the last General Election.
Actual Number of Electors - -	434	

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - 61

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in 2 of the 3 Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was - - - -	18,584
The present Gross Estimated Rental is - - - - - -	26,866
Increase - - -	8,282

The Rateable Value—	£	
In 1856 was - -	14,796	Increase since 1856 £8,483
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	16,290	since 1862 £6,989
The present Rateable Value is - - -	23,279	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - - -	26,556
The Gross Estimated Rental of the same description of Property according to the Valuation List is	25,388

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	314
£6 and under £7 - - -	129
£7 and under £8 - - -	42
£8 and under £9 - - -	57
£9 and under £10 - - -	11
£10 and over - - - -	468
	1,021

At a Rateable Value of—	
£4 and under £5 is - - -	111
£5 and under £6 - -	127
£6 - - - - -	55
Above £6 and under £7 -	48
£7 and under £8 - -	32
£8 and under £9 -	48
£9 and under £10 - -	23
£10 and over - - -	435

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 10 to 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

93. LIVERPOOL.

Population in 1831 -	201,751	Population in 1861 -	443,938	Increase	242,187
		Population in 1866 (computed) -	482,409	Increase -	280,658

Inhabited Houses in 1861 - - 65,781

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers -	7,655	20,554	12,899	—
Freemen - -	3,628	1,285	—	2,343
Total -	11,283	21,839	12,899	2,343

Net Increase. 10,556

Double entries on Register of 1865–6:—

As £10 Occupiers - -	840	1,221	
As £10 Occupiers and Freemen -	381		Number of Votes recorded at the last General Election.
Actual Number of Electors -		20,618	22,526

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - -	2,476
As Freemen - - - -	312
Total - - -	2,788
Double entries - - -	108
Net Number - -	2,680

Number of Burgesses - - - - - - - - - 15,102

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 614

Number of Burgesses on the Parliamentary Register - - - - 13,396

The Small Tenements Act has been adopted in the Parishes of Toxteth Park and West Derby.

There is no Act in force for rating Owners in the Parishes of Liverpool, Kirkdale, and Everton.

The Gross Estimated Rental—	£
In 1856 was - - -	1,680,824
The present Gross Estimated Rental is - - - - -	2,655,888
Increase - -	975,064

The Rateable Value—	£	
In 1856 was - -	1,527,831	Increase since 1856
The present Rateable Value is - -	2,402,584	£874,753

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	2,248,277
The Gross Estimated Rental of the same description of Property according to the last Poor Rate or Valuation List is - - - - - - - - -	2,235,748

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	1,385
£6 and under £7 - - -	3,152
£7 and under £8 - - -	5,245
£8 and under £9 - - -	5,935
£9 and under £10 - - -	4,737
£10 and over - - -	40,079*
	60,533

At a Rateable Value of—	
£4 and under £5 is - - -	989
£5 and under £6 - - -	3,329
£6 - - - -	7,040
Above £6 and under £7 - -	—
£7 and under £8 - - -	6,015
£8 and under £9 - -	5,140
£9 and under £10 - - -	4,439
£10 and over - - -	38,920

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the townships of Everton, Kirkdale, and West Derby; 25 per cent. in the township of Toxteth Park; and in the Parish of Liverpool a uniform deduction of £1 is made; for example, a Gross Estimated Rental of £10 becomes a Rateable Value of £9; one of £9 becomes £8; &c.

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* The difference between the number of Male Occupiers at £10 Gross Estimated Rental and the number of Electors on the Register as £10 Occupiers is attributable to disqualification on account of the length of occupation not being sufficient, nonpayment of rates, and the calling of persons, as Officers of the Excise, Customs, &c. In Liverpool Parish from 90 to 95 per cent. of the difference is accounted for by the rates not having been paid in full in the case of Occupiers of tenements of the annual rateable value of £15 and under. Many names also are struck off by the Revising Barrister on account of non-attendance to support claims to vote.

In Liverpool Parish there are 16 houses let out in distinct tenements. The annual rateable value of the occupations in the case of these tenements is as follows:—At £10, 3; at £9, 11; at £8, 2; at £6, 9; at £5, 21; at £4, 9; at £3, 3. In the other townships in the borough there are no houses so let out.

A weekly rental of 3*s.* 3*d.* or 3*s.* 6*d.*, the landlord paying the rates, represents a Gross Estimated Rental of £7 and a Rateable Value of £6.

94. LONDON.

Population in 1831 -	122,531	Population in 1861 -	112,063	Decrease -	10,468
		Population in 1866 (computed) -	104,908	Decrease -	17,623

Inhabited Houses in 1861 - - 13,298

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase	Decrease.
£10 Occupiers - -	9,057	12,020	2,963	—
Liverymen	9,527	5,514	—	4,013
Total	18,584	17,534	2,963	4,003
			Net Decrease. 1,050	

Double entries on Register of 1865-6 :—

As £10 Occupiers - - -	440	2,000	
As £10 Occupiers and Liverymen -	1,560		Number who voted at the last General Election.
Actual Number of Electors - -		15,534	10,997

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	1,141
As Liverymen - - - - - -	238
Total - - - -	1,379

Local Acts appear to be in force in the following Parishes:—

St. Botolph without Aldgate. *51 Geo. 3. c. 153.*, with rating limit of £20 yearly rent or value, except where houses are let weekly or to monthly tenants, or at rents payable at any shorter periods than quarterly, or let ready furnished or in lodgings or separate apartments.

St. Botolph without Bishopsgate. 35 Geo. 3. c. 61. applies to houses let out in separate apartments or ready furnished, or let for a less rent than £10 per annum.

St. Bride. 7 Geo. 4. c. 114., with rating limit of £30 yearly rent or value, except where houses are let for any period less than one year, or ready furnished, or in separate apartments.

The Gross Estimated Rental—	£
In 1856 was - - -	1,193,412
The present Gross Estimated Rental is - - - - - -	2,363,633
Increase - - -	1,170,221

The Rateable Value—	£	
In 1856 was - -	986,472	Increase since 1856 £934,110
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	1,093,384	since 1862 £827,198
The present Rateable Value is - - - -	1,920,582	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	2,030,438*
The Gross Estimated Rental of the same description of Property according to the Valuation List is	2,303,664*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—†	
Under £6 is - - - -	40
£6 and under £7 - - -	47
£7 and under £8 - - -	15
£8 and under £9 - - - -	21
£9 and under £10 - - -	10
£10 and over - - - - -	12,652
	12,785

At a Rateable Value of—†	
£4 and under £5 is - - -	2
£5 and under £6 - - -	29
£6 - - - - -	29
Above £6 and under £7 - -	59
£7 and under £8 - - -	17
£8 and under £9 - -	60
£9 and under £10 - - -	32
£10 and over - - - -	12,555

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The explanation offered of the discrepancy in these amounts is that certain properties, such as gas and water pipes, telegraph wires, hospitals &c., which are rated to the Poor Rate, are not assessed to the Income Tax, Schedule A.

† No Return has been received for the Middle Temple.

In the City of London Union there are 619 blocks of buildings let out as offices, counting-houses, &c., for which the names of the original lessees only appears on the Rate Book, and not the name of the Occupiers. The number cannot be ascertained, except by house to house visitation.

95. LUDLOW.

Population in 1831	5,870	Population in 1861	6,033	Increase	163
		Population in 1866 (computed)	6,391	Increase	521

Inhabited Houses in 1861 - - - 1,253

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	395	395	—
Freemen	59	31	—	28
Scot and Lot Voters	300	—	—	300
Total	359	426	395	328
			Net Increase. 67	

Double entries on Register of 1865–6:—

As £10 Occupiers	16	26	Number who voted at the last General Election.
As £10 Occupiers and Freemen	10		
Actual Number of Electors		400	338

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	63
As Freemen	2
Total	65

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in 3 of the 4 Parishes.

The Gross Estimated Rental—	£
In 1856 was	21,557
The present Gross Estimated Rental is	19,121
Decrease	2,436

The Rateable Value—	£	
In 1856 was	16,840	Decrease since 1856 £2,722
In 1862 immediately before the date of the Union Assessment Committee Act it was	13,355	
The present Rateable Value is	14,118	Increase since 1862 £763

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	19,532
The Gross Estimated Rental of the same description of Property according to the Valuation List is	17,811

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	353
£6 and under £7	92
£7 and under £8	29
£8 and under £9	36
£9 and under £10	4
£10 and over	423
	937

At a Rateable Value of—	
£4 and under £5 is	111
£5 and under £6	11
£6	3
Above £6 and under £7	28
£7 and under £8	5
£8 and under £9	99
£9 and under £10	35
£10 and over	286

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and over £8, and of 30 per cent. in the case of Houses under £8.

96. LYME REGIS.

Population in 1831 - 3,345	Population in 1861	- 3,215	Decrease - 130
	Population in 1866 (computed)	- 3,074	Decrease - 271

Inhabited Houses in 1861 - - 683

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	208	250	42	—
Freemen - - - -	14	2	—	12
Total - -	222	252	42	12
			Net Increase. 30	

Double entries on Register of 1865–6 :—

As £10 Occupier - -	1	2	Number who voted at the last General Election.
As £10 Occupier and Freeman	1		
Actual Number of Electors - -		250	223

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - 49

The Small Tenements Act is in force in one of the two Parishes constituting this Borough.

The Gross Estimated Rental—	£
In 1856 was - - - -	13,221
The present Gross Estimated Rental is - - - - -	14,680
Increase - - - -	1,459

The Rateable Value—	£	
In 1856 was - -	10,198	Increase since 1856 £2,386
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	10,347	since 1862 £2,237
The present Rateable Value is - - - -	12,584	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	15,168
The Gross Estimated Rental of the same description of Property according to the Valuation List is	14,028

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	222
£6 and under £7 - - - -	34
£7 and under £8 - - - -	20
£8 and under £9 - - - -	20
£9 and under £10 - - - -	27
£10 and over - - - -	317
	640

At a Rateable Value of—	
£4 and under £5 is - - - -	64
£5 and under £6 - - - -	29
£6 - - - - - -	9
Above £6 and under £7 - -	18
£7 and under £8 - - - -	43
£8 and under £9 - - -	46
£9 and under £10 - - - -	28
£10 and over - - - -	229

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 15 to 25 per cent., varying according to the condition of the premises, is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6 and under £10, and from 25 to 33⅓ per cent. in the case of Houses at and under £6.

97. LYMINGTON.

Population in 1831 -	5,361	Population in 1861 -	5,179	Decrease -	182
		Population in 1866 (computed) -	5,128	Decrease -	233

Inhabited Houses in 1861 - - - 1,025

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	249	349	100

Double entries on Register of 1865–6 :—		Number who voted at the last General Election.
As £10 Occupiers - - - - - -	2	
Actual Number of Electors - - -	347	272

Number of Working Classes on the present Parliamentary Register - - 74

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - - -	20,565
The present Gross Estimated Rental is - - - - - -	22,873
Increase - - -	2,308

The Rateable Value—	£	
In 1856 was - -	16,818	Increase since 1856 £2,139
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	17,710	since 1862 £1,247
The present Rateable Value is - - - -	18,957	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	24,505
The Gross Estimated Rental of the same description of Property according to the Valuation List is	22,254

The Number of Male Occupiers :—

At a Gross Estimated Rental—	
Under £6 is - - - - -	252
£6 and under £7 - - -	121
£7 and under £8 - - -	61
£8 and under £9 - - -	24
£9 and under £10 - - -	4
£10 and over - - -	408
	870

At a Rateable Value of—	
£4 and under £5 is - - -	43
£5 and under £6 - - -	106
£6 - - - - - -	39
Above £6 and under £7 - -	25
£7 and under £8 - - -	4
£8 and under £9 - - -	113
£9 and under £10 - - -	45
£10 and over - - - -	289

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6, and of 25 per cent. under £6.

98. MACCLESFIELD.

Population in 1831	30,408	Population in 1861	36,101	Increase	5,693
		Population in 1866 (computed)	34,712	Increase	4,304

Inhabited Houses in 1861 - - 8,342

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	718	964	246

		Number who voted at the last General Election.
Double entries on Register	103	
Actual Number of Electors	861	838

Number of Working Classes on the present Parliamentary Register - - 80*

Number of Burgesses - - - - - - - - - 6,061

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 5,194

Number who are on the Parliamentary Register - - - - - - 867

The Small Tenements Act is in force. Before its adoption the number of Burgesses was 1,686.

The Gross Estimated Rental—	£
In 1856 was	86,851
The present Gross Estimated Rental is	88,583
Increase	1,732

The Rateable Value—	£	
In 1856 was	78,442	Decrease since 1856 £3,232
In 1862 immediately before the date of the Union Assessment Committee Act it was	76,595	
The present Rateable Value is	75,210	since 1862 £1,385

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	85,022
The Gross Estimated Rental of the same description of Property according to the Valuation List is	84,372

The Number of Male Occupiers:—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	3,573	£4 and under £5 is	1,475
£6 and under £7	950	£5 and under £6	890
£7 and under £8	471	£6	402
£8 and under £9	227	Above £6 and under £7	190
£9 and under £10	65	£7 and under £8	79
£10 and over	1,055	£8 and under £9	35
		£9 and under £10	284
	6,341	£10 and over	868

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 10 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £10, 15 per cent. in the case of Houses at £6 and under £10, and 20 per cent. for Houses under £6.

Where the Owner pays the rates, he makes an addition to the rent of 6*s.* in the pound upon the rental.

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* Mr. May, Clerk to the Guardians, states with reference to the small number of the Working Clases on the Register that wages have been lower and much more precarious in Macclesfield than elsewhere for a series of years, and that the distress amongst the operative class has been severe and trying. In consequence the rents of cottages and houses generally are much lower than in other towns, and of late years they have so materially diminished in value as to render them absolutely unprofitable. There are upwards of 1,000 houses in the borough unoccupied. A house of £10 value in Macclesfield would be worth £15 in the prosperous towns of Yorkshire and Lancashire.

99. MAIDSTONE.

Population in 1831	15,790	Population in 1861	23,058	Increase	7,268
		Population in 1866 (computed)	24,277	Increase	8,487

Inhabited Houses in 1861 - - 4,119

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase	Decrease.
£10 Occupiers	652	1,572	920	—
Freemen	456	401	—	55
Total	1,108	1,973	920	55
			Net Increase. 865	

Double entries on Register of 1865-6 :—

As £10 Occupiers and Freemen	156	Number who voted at the last General Election.
Actual Number of Electors	1,817	1,696

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	598
As Freemen	262
Total	860
Deduct Double entries	58
Net Number	802[*]

Number of Burgesses	2,036
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	1,201
Number of Burgesses on the Parliamentary Register	1,328

The Parliamentary and Municipal Boundaries are not conterminous, but nearly so. A small portion of land within the Parliamentary limit is out of the Municipal Boundary.

The 59 Geo. 3. c. 12. is in force throughout the Borough, the limit for rating the Owner being £20. There is also a Local Act, 45 Geo. 3. c. 118., with a rating limit not exceeding £12 rental, except where Houses are underlet, or let out in lodgings or separate apartments.

The Gross Estimated Rental—	£
In 1856 was	95,390
The present Gross Estimated Rental is	97,532
Increase	2,142

The Rateable Value—	£	
In 1856 was	79,349	Increase since 1855 £6,362
In 1862 immediately before the date of the Union Assessment Committee Act it was	84,513	
The present Rateable Value is	85,711	since 1862 £1,198

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	104,740[†]
The Gross Estimated Rental of the same description of Property according to the Valuation List is	94,303[†]

The Number of Male Occupiers :—[‡]

At a Gross Estimated Rental of—	
Under £6 is	792
£6 and under £7	441
£7 and under £8	296
£8 and under £9	370
£9 and under £10	325
£10 and over	2,193
	4,417

At a Rateable Value of—	
£4 and under £5 is	360
£5 and under £6	525
£6	246
Above £6 and under £7	61
£7 and under £8	632
£8 and under £9	507
£9 and under £10	213
£10 and over	1,529

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 20 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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[*] It is stated that a large number of the Working Classes on the Register are paper makers and mariners.

[†] The assessment of mills to the Income Tax is much higher than to the Poor Rate. In 16 cases in which comparison was made the Income Tax Assessment is £9,784, whilst the Poor Rate Assessment is only £5,273, and nearly half of the difference between the totals of the two assessments is thus accounted for.

[‡] When the Owners are assessed in lieu of the Occupiers, and the names of the Occupiers do not appear in the Rate, the number of tenements is given.

100. MALDON.

Population in 1831	4,895	Population in 1861	6,261	Increase	1,366
		Population in 1866 (computed)	6,456	Increase	1,561

Inhabited Houses in 1861 - 1,329

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	Qualifications not distinguished.	308	188
Freemen		596	
Total	716	904	188

Double entries on Register of 1865–6:—

As £10 Occupiers	4	45	Number who voted at the last General Election.
As £10 Occupiers and Freemen	41		
Actual Number of Electors		859	799

Number of Working Classes on the present Parliamentary Register:—

As 10 Occupiers	54
As Freemen	425
Total	479

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force.

The Gross Estimated Rental—	£
In 1856 was	20,350
The present Gross Estimated Rental is	25,348
Increase	4,998

The Rateable Value—	£	
In 1856 was	16,480	Increase since 1856 £4,986
In 1862 immediately before the date of the Union Assessment Committee Act it was	17,825	since 1862 £3,641
The present Rateable Value is	21,466	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	25,651
The Gross Estimated Rental of the same description of Property according to the Valuation List is	24,910

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	523
£6 and under £7	141
£7 and under £8	156
£8 and under £9	43
£9 and under £10	23
£10 and over	320
	1,206

At a Rateable Value of—	
£4 and under £5 is	304
£5 and under £6	203
£6	74
Above £6 and under £7	26
£7 and under £8	33
£8 and under £9	42
£9 and under £10	32
£10 and over	249

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 10 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

101. MALMSBURY.

Population in 1831 - 6,136	Population in 1861 -	6,881	Increase	-	745
	Population in 1866 (computed) -	6,823	Increase	-	687

Inhabited Houses in 1861 - - 1,406

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	278	357	79
Freemen - - -	13	13	—
Total - - -	291	370	79

Double entries on Register of 1865–6 :—			
As £10 Occupiers - -	35	41	
As £10 Occupiers and Freemen	6		Number who voted at the last General Election.
Actual Number of Electors - -		329	293

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - 47*

The Small Tenements Act has been adopted throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was - - -	36,269
The present Gross Estimated Rental is - - - - -	40,743
Increase - - -	4,474

The Rateable Value—	£	
In 1856 was - -	32,451	Increase since 1856 £3,583
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	32,433	since 1862 £3,601
The present Rateable Value is - - -	36,034	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	42,343
The Gross Estimated Rental of the same description of Property according to the Valuation List is	40,716

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - -	681
£6 and under £7 - - - - -	63
£7 and under £8 - - -	42
£8 and under £9 - - -	29
£9 and under £10 - - -	20
£10 and over - - - - -	352
	1,187

At a Rateable Value of—	
£4 and under £5 is - - -	172
£5 and under £6 - - -	36
£6 - - - - -	10
Above £6 and under £7 - -	26
£7 and under £8 - - -	19
£8 and under £9 - - -	36
£9 and under £10 - - -	34
£10 and over - - -	325

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the number of the Working Class on the Register, it is stated that there is a silk manufactory in Malmsbury employing a large number of hands, and that upwards of 280 householders, principally of the Working Class, derive emoluments from certain corporation properties bequeathed to the Inhabitants of the Borough, and their successors for ever, by King Athelstan for the valour of their ancestors in a battle fought with the Danes.

102. MALTON.

Population in 1831 - 6,802	Population in 1861	- 8,072	Increase	-	1,270
	Population in 1866 (computed)	- 8,286	Increase	-	1,484

Inhabited Houses in 1861 - - 1,694

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	375	592	217	—
Scot and Lot Voters - -	292	11	—	281
Total - - -	667	603	217	281
			Net Decrease. 64	

Double entries on Register of 1865–6:—

As £10 Occupiers - - - -	3
Actual Number of Electors - -	600

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - -	47
As Scot and Lot Voters - - -	9
Total - - -	56

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—	£
In 1856 was - - -	30,041
The present Gross Estimated Rental is - - - - -	29,843
Decrease - -	198

The Rateable Value—	£	
In 1856 was - -	24,770	Increase since 1856 £840
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	26,077	
The present Rateable Value is - - -	25,610	Decrease since 1862 £467

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	30,365
The Gross Estimated Rental of the same description of Property according to the Valuation List is	26,931

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	681
£6 and under £7 - - - -	59
£7 and under £8 - - -	36
£8 and under £9 - - -	35
£9 and under £10 - - -	10
£10 and over - - - -	497*
	1,318

At a Rateable Value of—	
£4 and under £5 is - - -	95
£5 and under £6 - - -	97
£6 - - - - -	12
Above £6 and under £7 - - -	36
£7 and under £8 - - - -	23
£8 and under £9 - - -	57
£9 and under £10 - - -	13
£10 and over - - - -	416

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the excess of Electors on the Register as £10 Occupiers over the Male Occupiers at £10 Gross Estimated Rental, it is stated that in the Parish of Old Malton there are 72 acres or thereabouts of land belonging to one proprietor, who is also owner of houses in New Malton and Old Malton, both within the Borough; this land is let to the occupiers of the houses in small plots varying from one acre to a rood each, and the rent of the land being added to the rent of the houses in many instances raises the actual rental paid by the tenant to £10. The proprietor of the land is rated for the same in one sum, and the value of the land occupied by the tenants does not appear against their names in the Rate Book, and consequently they are not included in the Return as £10 Occupiers. As, however, the tenant proves the payment of rent amounting to £10, he is placed on the Register. There may also be cases in which the Overseers have under-estimated the annual value of dwelling-houses

103. MANCHESTER.

Population in 1831 - 187,022 { Population in 1861 - 357,979 Increase - 170,957
Population in 1866 (computed) - 380,887 Increase - 193,865

Inhabited Houses in 1861 - - 65,375

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	6,726	22,792	16,066

Double entries on Register of 1865–6 :—

As £10 Occupiers - - -	1,250	Number who voted at the last General Election.
Actual Number of Electors -	21,542	14,916

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 5,822

The Parliamentary and Municipal Boundaries are not conterminous.

A Local Act, 21 & 22 Vict. c. 62. (the Manchester Overseers Act), is in force in the Parishes of Manchester, Ardwick, Chorlton-upon-Medlock, and Hulme. Under it Owners are to be rated for Houses not exceeding £10 annual Rateable Value, and for Houses, &c. let or sub-let in separate apartments as storehouses. By sect. 13 Occupiers are authorized to claim to be rated, and upon payment of the rate due, if any, they are to be deemed as rated from the time of making the claim.

The Small Tenements Act appears to have been adopted in two of the nine Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was - - -	1,427,600
The present Gross Estimated Rental is - - - -	1,676,785
Increase - -	249,185

The Rateable Value—	£	
In 1856 was - -	1,189,086	Increase since 1856
The present Rateable Value is - -	1,398,607	£209,521

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	1,589,726
The Gross Estimated Rental of the same description of Property according to the last Poor Rate or Valuation List is - - - - - - - - -	1,578,643

The Number of Male Occupiers :—†

At a Gross Estimated Rental of—	
Under £6 is - - -	13,823
£6 and under £7 - - - -	6,922
£7 and under £8 - - -	6,599
£8 and under £9 - -	5,875
£9 and under £10 - - - -	2,656
£10 and over - -	27,906*
	63,781

At a Rateable Value of—	
£4 and under £5 is - - - -	7,792
£5 and under £6 - - -	9,737
£6 - - - - -	1,252
Above £6 and under £7 - -	5,318
£7 and under £8 - - -	3,743
£8 and under £9 - - -	5,175
£9 and under £10 - -	3,682
£10 and over - -	20,047

The Gross Estimated Rental is stated to represent the full rack rent.

With the exception of the townships of Ardwick, Chorlton-upon-Medlock, and Hulme, in which 20 per cent. is deducted, a deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The difference between the number of Male Occupiers at £10 Gross Estimated Rental and Electors on the Register as £10 Occupiers is attributable to the number of persons who have not resided or have not been rated for a sufficient period.

† In the Township of Manchester there are 211 houses let out in distinct tenements, and these are included in the Returns according to the value of the respective occupations so far as they could be ascertained. There are no houses of this character in the other townships in the City.

104. MARLBOROUGH.

Population in 1831 -	4,186	Population in 1861 -	4,893	Increase - 707
		Population in 1866 (computed) -	4,776	Increase - 590

Inhabited Houses in 1861 - - 821

Number of Electors on Parliamentary Register :—

	1836–7. (No Return for 1832-3.)	1865–6.	Increase.	Decrease.
£10 Occupiers - - -	272	303	31	—
Freemen - - - - -	8	1	—	7
Total - - - -	280	304	31	7
			Net Increase. 24	

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	28	29
As £10 Occupier and Freeman -	1	
Actual Number of Electors - -		275

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 99

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - -	16,449
The present Gross Estimated Rental is - - - -	19,109
Increase - - - -	2,660

The Rateable Value—	£	
In 1856 was - - -	13,578	Increase since 1856 £2,554
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	13,433	since 1862 £2,699
The present Rateable Value is - - -	16,132	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	19,469
The Gross Estimated Rental of the same description of Property according to the Valuation List is	18,800*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	258
£6 and under £7 - - - -	103
£7 and under £8 - - - -	44
£8 and under £9 - - - -	23
£9 and under £10 - - -	14
£10 and over - - - -	271†
	713

At a Rateable Value of—	
£4 and under £5 is - - -	167
£5 and under £6 - - -	84
£6 - - - - - - -	5
Above £6 and under £7 - - -	25
£7 and under £8 - - - -	16
£8 and under £9 - - -	38
£9 and under £10 - - - -	25
£10 and over - - - -	210

The Gross Estimated Rental is stated to represent the full rack rent.

On an average a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10. In the Parish of Preshute the deductions are from 20 to 30 per cent.

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* The difference between the two assessments is thus explained :—In the Income Tax Assessment for Preshute in two or three instances farms situate partly in Preshute and partly in other parishes not within the Parliamentary Borough are assessed wholly in Preshute. In several instances also the Income Tax Assessment is raised by the Surveyor or otherwise above the Gross Estimated Rental of the Valuation List.

† The explanation given of the difference between the number of Male Occupiers at £10 Gross Estimated Rental (271) and the number of persons on the Register as £10 Occupiers (275) is as follows : The Parliamentary List is dated July 1865, whereas the Valuation Lists were made at various dates in the previous year.

105. GREAT MARLOW.

Population in 1831 -	6,175	Population in 1861 -	6,496	Increase -	321
		Population in 1866 (computed) -	6,483	Increase -	308

Inhabited Houses in 1861 - - 1,284

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers - -	95	329	234	—
Scot and Lot Voters - -	362	25	—	337
Total - -	457	354	234	337

Net Decrease.
103

Double entries on Register of 1865-6:—

As £10 Occupiers - -	3	5
As £10 Occupiers and Scot and Lot Voters - - -	2	
Actual Number of Electors - -		349

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - -	125
As Scot and Lot Voters - - -	22
Total - - - -	147*

The Small Tenements Act is in force in 2 of the 4 Parishes.

The Gross Estimated Rental—	£
In 1856 was - - -	27,195
The present Gross Estimated Rental is - - - - -	32,646
Increase - - -	5,451

The Rateable Value—	£	
In 1856 was - - -	23,081	Increase since 1856 £4,771
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	23,448	since 1862 £4,404
The present Rateable Value is - - -	27,852	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	37,190
The Gross Estimated Rental of the same description of Property according to the Valuation List is	32,345†

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	544
£6 and under £7 - - -	72
£7 and under £8 - - -	27
£8 and under £9 - - -	23
£9 and under £10 - - -	15
£10 and over - - -	359
	1,040

At a Rateable Value of—	
£4 and under £5 is - - - -	189
£5 and under £6 - - -	52
£6 - - - - -	8
Above £6 and under £7 - -	22
£7 and under £8 - - -	19
£8 and under £9 - - -	80
£9 and under £10 - - -	43
£10 and over - - -	271

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 15 to 25 per cent., according to state of repair, is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parishes of Great Marlow and Little Marlow, according to the condition of the Houses, a deduction on the average of 17½ per cent. in the Parish of Medmenham, and of 20 per cent. in the Parish of Bisham.

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* The large number of the Working Class on the Register it is stated is attributable to a large brewery in the Borough, and a large shoe manufactory in the neighbourhood, also to cottages of small rentals being let to one person, the portion not required by him being sublet to others.

† The difference between the two assessments it is stated may be accounted for by the Woodlands, which are considerable, being included in the Income Tax Assessment, and not in the Poor Rate Return. Tithe rentcharge to the amount of £2,780 is included in the former assessment, and not in the latter. The Returns of Rents made to the Income Tax Commissioners are in most cases much higher than the Gross Estimated Rental in the Valuation Lists.

106. MARYLEBONE.

Population in 1831 - 240,294	Population in 1861 -	436,252	Increase -	195,958
	Population in 1866 (computed) -	473,091	Increase -	232,797

Inhabited Houses in 1861 - - 47,896

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	8,901	23,888	14,987
Double entries on Register of 1865–6 :— As £10 Occupiers, estimated - - -		300	Number who voted at the last General Election.
Actual Number of Electors - -		23,588	11,067

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 5,103*

A Local Act, 5 Geo. 4. c. 126., with a rating limit not exceeding £20 yearly rent or value, except where Houses are let to weekly or monthly tenants or in separate apartments, and at rents collected at a shorter period than quarterly, is in force in Paddington. Another Local Act, 59 Geo. 3. c. 39., with a similar provision, in St. Pancras. And another Local Act, 3 Geo. 4. c. 84., with a rating limit not exceeding £20 nor less than £6, for Houses let for any less term than one year, or with rents payable at any shorter period than three months.

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was - - -	2,442,611	In 1856 was - -	2,160,417	Increase since 1856
The present Gross Estimated Rental is	3,093,030	The present Rateable Value is - -	2,634,503	£474,086
Increase - - -	650,419			

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	3,136,063
The Gross Estimated Rental of the same description of Property according to the Poor Rate is -	2,955,562

The Number of Male Occupiers :—

—	At a Gross Estimated Rental of								At a Rateable Value of							
	Under £4.	£4 and under £5.	£5 and under £6.	£6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.	£4 and under £5.	£5 and under £6.	£6.	Above £6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.
St. Marylebone -	3	—	33	16	83	56	213	11,666	35	20	80	15	72	227	74	11,677
St. Pancras - -	—	1	4	5	19	9	15	16,070	5	—	22	—	2	62	—	16,153
Paddington - -	—	—	1	19	14	56	6	7,449	1	40	44	5	27	70	73	7,281
Total - -	3	1	38	40	116	121	234	35,185	41	60	146	20	101	359	147	35,111

The number of Tenements included in the above for which the Owners are rated instead of the Occupiers, and which are separately returned, is as follows:

St. Pancras - -	—	1	3	4	9	5	15	823	Tenements in respect of which Owners are rated not distinguished.
Paddington - -	—	—	1	18	14	54	6	721	

St. Marylebone Parish.—The Gross Estimated Rental represents the full rack rent. A deduction of 10 per cent. from the Gross Estimated Rental is allowed in arriving at the Rateable Value.

The number of Houses in the parish for which the Landlord is rated and does not reside therein is as follows: At £10 and over, 661; at £9, 66; at £8, 183; at £7, 54; above £6 and under £7, 12; at £6, 34; at £5, 16; at £4, 31. The value of the several occupations can only be ascertained by a house to house visitation. In these cases the number of tenements, and not of Male Occupiers, is given in the Return. In some instances the Occupiers of Houses let out in separate tenements have claimed to be rated, and have been placed on the Register, such claimants having a private and separate entrance to the house they in part occupy. The parties inhabiting the majority of such apartments are weekly tenants and of a migratory class.

St. Pancras Parish.—The Return as to Male Occupiers at a Gross Estimated Rental was based on the rate of April 1865, and that as to Rateable Value on the rate of October 1865. This explains the difference in the number of Male Occupiers at £10.

There are very few Houses in the parishes let out in distinct tenements. The annual value of each occupation in these cases can only be ascertained by a house to house visitation.

When the Owners are assessed instead of the Occupiers the Rateable Value is equal to two thirds of the rack rent.

The Gross Estimated Rental represents the full rack rent. A deduction of 15 per cent. is made from the Gross Estimated Rental to arrive at the Rateable Value in the cases in which the Owners do not compound.

Only 27 of the 823 £10 compound Occupiers have claimed to be rated for the purpose of being placed on the Register.

Paddington Parish.—The Gross Estimated Rental is stated to represent the full rack rent. A deduction of one fourth is made from the Gross Estimated Rental in fixing the Rateable Value.

Of the 721 £10 compound Occupiers about 60 are on the Register.

There are about 244 Houses in the parish which are let out in distinct tenements. The number and value of the separate occupations in these Houses can only be ascertained by a house to house visitation. The number of tenements is given in the Return. None of the Occupiers of these tenements are on the Register.

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* The number of the Working Classes on the Register for the Parish of St. Pancras was arrived at by an estimate. The number on one-fourth of the Register was ascertained to be 701, and the total for the entire Parish was estimated at four times that number, or 2,804. This course was adopted in consequence of a representation that without a house-to-house visitation the exact number for the whole Parish could not be ascertained.

107. MIDHURST.

Population in 1831	5,627	Population in 1861	6,405	Increase	778
		Population in 1866 (computed)	6,118	Increase	491

Inhabited Houses in 1861 - - 1,282

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	362	362	—
Scot and Lot Voters	252	—	—	252
Total	252	362	362	252

Net Increase. 110

Double entries on Register of 1865–6:—
As £10 Occupiers - - - - 53
Actual Number of Electors - - 309

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—
As £10 Occupiers - - - 50

The Small Tenements Act has been adopted in several of the Parishes.

The Gross Estimated Rental—	£
In 1856 was	29,936
The present Gross Estimated Rental is	33,728
Increase	3,792

The Rateable Value—	£	
In 1856 was	23,189	Increase since 1856 £5,046
In 1862 immediately before the date of the Union Assessment Committee Act it was	23,688	since 1862 £4,547
The present Rateable Value is	28,235	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	34,485
The Gross Estimated Rental of the same description of Property according to the Valuation List is	33,423

The Number of Male Occupiers:—

At a Gross Estimated Rental—	
Under £6 is	698
£6 and under £7	62
£7 and under £8	28
£8 and under £9	37
£9 and under £10	13
£10 and over	329
	1,167

At a Rateable Value of—	
£4 and under £5 is	39
£5 and under £6	34
£6	3
Above £6 and under £7	49
£7 and under £8	15
£8 and under £9	31
£9 and under £10	9
£10 and over	268

The Gross Estimated Rental is stated to represent the full rack rent.

In the several Parishes, with the exception of the Parish of Heyshott in which 10 per cent., and the Parish of Bignor in which 25 per cent., is deducted, a deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses over £6 and under £10, and 25 per cent. on Houses at and under £6.

108. MONMOUTH.

Population in 1831 -	13,585	Population in 1861 -	30,577	Increase -	16,992
		Population in 1866 (computed) -	32,838	Increase -	19,253

Inhabited Houses in 1861 - - - 5,154

Number of Electors on Parliamentary Register :—

	1836. (No Return for 1832-3.)	1865–6.	Increase.	Decrease.
£10 Occupiers - -	963	2,125	1,162	—
Freemen - - - -	206	21	—	185
Total - -	1,169	2,146	1,162	185

Net Increase.
977

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	48	59
As £10 Occupiers and Freemen	11	
Actual Number of Electors -		2,087

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	825
As Freemen - - - -	10
Total - - -	835
Deduct double entry -	1
Net Number -	834*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted throughout the Borough.

The Gross Estimated Rental—

	£
In 1856 was - - - - -	129,059
The present Gross Estimated Rental is - - - - - -	139,702
Increase - - -	10,643

The Rateable Value—

	£	
In 1856 was - -	96,632	Increase since 1856 £9,799
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	108,152	Decrease since 1862 £1,721
The present Rateable Value is - - -	106,431	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	113,267†
The Gross Estimated Rental of the same description of Property according to the Valuation List is	108,925†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	639
£6 and under £7 - - - - -	165
£7 and under £8 - - -	160
£8 and under £9 - - - -	241
£9 and under £10 - - -	170
£10 and over - - - -	2,714
	4,089

At a Rateable Value of—	
£4 and under £5 is - -	256
£5 and under £6 -	171
£6 - - - - - - -	162
Above £6 and under £7 - - - -	177
£7 and under £8 - - -	318
£8 and under £9 - - - -	344
£9 and under £10 - - -	454
£10 and over - - -	1,648

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parishes of Christchurch, Newport, and Saint Wollos, 20 per cent. in the Parishes of Dixton and Monmouth, and 15 per cent. in the Parish of Usk, The portion of the Borough within the Parish of Gwehelog does not contain any Houses of the description referred to.

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[*] With reference to the number of the Working Class on the Register, it is stated that in Newport rent is so exceedingly high that by far the greater proportion of houses are of the value of £10 a year and upwards, so that very many working men become entitled to the franchise by rental, who at the same time let out perhaps the greater part of their houses to lodgers. The large number returned for the contributory Borough of Usk is attributed to the general condition of the Working Classes themselves.

[†] The difference between the two assessments it is stated may be accounted for in Newport by double assessments to the Income Tax, and by the fact that since that assessment was made the rates on many properties have been reduced by the Assessment Committee on appeal. In Monmouth, in one or two instances items amounting to £840, and other large sums, are included in the Income Tax Assessment which do not appear in the Valuation Lists.

109. MORPETH.

Population in 1831	6,766	Population in 1861	13,794	Increase	7,028
		Population in 1866 (computed)	16,191	Increase	9,425

Inhabited Houses in 1861 - - 2,312

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	190	389	199	—
Freemen	131	96	—	35
Total	321	485	199	35
			Net Increase. 164	

Double entries on Register of 1865–6:—		
As £10 Occupiers	12	37
As £10 Occupiers and Freemen	25	
Actual Number of Electors		448

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	73
As Freemen	79
Total	152
Double entries	10
Net Number	142*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in one of the seven Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was	34,533
The present Gross Estimated Rental is	50,767
Increase	16,234

The Rateable Value—	£	
In 1856 was	31,365	Increase since 1856 £15,625
In 1862 immediately before the date of the Union Assessment Committee Act it was	39,347	
The present Rateable Value is	46,990	since 1862 £7,643

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	34,205
The Gross Estimated Rental of the same description of Property according to the Valuation List or Poor Rate is	33,541

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	957
£6 and under £7	65
£7 and under £8	40
£8 and under £9	52
£9 and under £10	16
£10 and over	455
	1,585

At a Rateable Value of—	
£4 and under £5 is	107
£5 and under £6	76
£6	19
Above £6 and under £7	47
£7 and under £8	31
£8 and under £9	38
£9 and under £10	24
£10 and over	391

The Gross Estimated Rental is stated to represent the full rack rent. In Norfolk township and Buller's Green the Small Tenements Rating Act is in operation, and tenements under £6 are rated in Norfolk at one half and Buller's Green at three fourths of the actual rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* It is stated that the population of Morpeth is very much composed of coal-miners, and a considerable number of them, though continuing to follow their occupation of coal-miners, take public-houses and beer-shops, for which they pay a rent of £10 or upwards.

110. NEWARK.

Population in 1831 -	9,557	Population in 1861 -	11,515	Increase - 1,958
		Population in 1866 (computed) -	11,609	Increase - 2,052

Inhabited Houses in 1861 - - 2,558

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	—	540	540	—
Scot and Lot Voters - -	1,575	171	—	1,404
Total - -	1,575	711	540	1,404

Net Decrease.
864

Double entries on Register of 1865–6:—

As £10 Occupier, and Scot and Lot Voter -	1
Actual Number of Electors -	710

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - -	164
As Scot and Lot Voters - -	115
Total - -	279

Number of Burgesses - - - - - -	1,534
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	None.
Number of Burgesses on the Parliamentary Register - - - -	662

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—	£
In 1856 was - - -	32,739
The present Gross Estimated Rental is - - - - -	46,526
Increase - - -	13,787

The Rateable Value—	£	
In 1856 was - -	25,733	Increase since 1856 £14,103
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	28,367	
The present Rateable Value is - -	39,836	since 1862 £11,469

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	39,916
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate - - - - - - - - - - -	42,310

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	1,047
£6 and under £7 - - -	199
£7 and under £8 - - -	151
£8 and under £9 - - -	66
£9 and under £10 - - -	42
£10 and over - - -	653
	2,158

At a Rateable Value of—	
£4 and under £5 is -	327
£5 and under £6 - -	218
£6 - -	34
Above £6 and under £7 -	121
£7 and under £8 - - -	58
£8 and under £9 - -	70
£9 and under £10	55
£10 and over	573

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 10 to 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parish of Newark, and £10per cent. for Houses above £6, and £20 per cent. for Houses at and under £6, in the Parish of East Stoke.

It is stated that there are no cases of weekly rental except under £6 rent. A Gross Estimated Rental of £7 10*s*. represents a Rateable Value of £7 10*s*.

111. NEWCASTLE-UNDER-LYME.

Population in 1831	8,192	Population in 1861	12,938	Increase	4,746
		Population in 1866 (computed)	14,315	Increase	6,123

Inhabited Houses in 1861 - - 2,659

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	131	463	332	—
Freemen	842	718	—	124
Total	973	1,181	332	124
			Net Increase. 208	

Double entries on Register of 1865–6 :— As £10 Occupiers and Freemen	104	Number who voted at the last General Election.
Actual Number of Electors	1,077	891

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	36
As Freemen	575
Total	611
Deduct Double entries	22
Net Number	589*

Number of Burgesses	1,001
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	None.
Number of Burgesses on the Parliamentary Register	582

The Gross Estimated Rental—

	£
In 1856 was	25,667
The present Gross Estimated Rental is	34,204
Increase	8,537

The Rateable Value—

	£	
In 1856 was	24,226	Increase since 1856 £4,029
In 1862 immediately before the date of the Union Assessment Committee Act it was	28,031	since 1862 £224
The present Rateable Value is	28,255	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	35,129
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is	33,044

The Number of Male Occupiers :—†

At a Gross Estimated Rental—	
Under £6 is	1,326
£6 and under £7	298
£7 and under £8	123
£8 and under £9	59
£9 and under £10	20
£10 and over	609
	2,435

At a Rateable Value of—	
£4 and under £5 is	555
£5 and under £6	374
£6	—
Above £6 and under £7	93
£7 and under £8	38
£8 and under £9	79
£9 and under £10	17
£10 and over	506

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The large number of the Working Classes on the Register is accounted for by the Freemen possessing the franchise.

† There are a good many houses in the Borough called double houses, which are occupied by two or more families, but in all these cases the assistant overseers rate the tenants, and the Male Occupiers are included in the Return.

112. NEWCASTLE-ON-TYNE.

Population in 1831 - 53,613	Population in 1861	-	109,108	Increase -	55,495
	Population in 1866 (computed)	-	121,640	Increase -	68,027

Inhabited Houses in 1861 - - 13,979

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	2,286	5,618	3,332
Freemen - - -	1,619	1,842	223
Total - -	3,905	7,460	3,555

Double entries on Register of 1865–6:—

As £10 Occupiers - -	421	830	
As £10 Occupiers and Freemen	409		Number who voted at the last General Election.
Actual Number of Electors - -		6,630	4,746

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - -	920
As Freemen - - - -	742
Total - - -	1,662
Deduct Double entries -	103
Net Number - -	1,559

Number of Burgesses - - - - - - - - - -	9,924
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	3,551
Number of Burgesses on the Parliamentary Register - - - - - -	6,788

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was - - -	301,368
The present Gross Estimated Rental is - - - -	400,337
Increase - - -	98,969

The Rateable Value—	£	
In 1856 was - -	254,744	Increase since 1856 £79,723
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	301,864	since 1862 £32,603
The present Rateable Value is - - -	334,467	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	376,442
The Gross Estimated Rental of the same description of Property according to the Valuation List is	373,847

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	8,499
£6 and under £7 - - -	1,952
£7 and under £8 - - -	1,242
£8 and under £9 - - -	1,486
£9 and under £10 - - -	1,211
£10 and over - - -	6,827
	21,217

At a Rateable Value of—	
£4 and under £5 is - - -	5,891
£5 and under £6 - - -	1,801
£6 - - - - - -	1,269
Above £6 and under £7 - -	1,349
£7 and under £8 - - -	1,304
£8 and under £9 - - - -	1,524
£9 and under £10 - - - -	1,502
£10 and over - - - -	6,456

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 10 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and in two Parishes there is a deduction of half of the residue. In the case of compounded Houses 10 per cent. is deducted, and the Owner is rated on half of the balance.

113. NEWPORT, ISLE OF WIGHT.

Population in 1831	- 6,700	Population in 1861 -	7,934	Increase -	1,234
		Population in 1866 (computed) -	7,878	Increase -	1,178

Inhabited Houses in 1861 - - 1,591

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	410	662	252	—
Freemen - - -	15	2	—	13
Total - -	425	664	252	13
			Net Increase. 239	

Double entries on Register of 1865–6:—

As £10 Occupiers - - -	19	21		
As £10 Occupiers and Freemen - -	2			
			Number who voted at the last General Election.	
Actual Number of Electors -		643	547	

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - 219*

Number of Burgesses - - - - - - - - - -	736
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	71
Number of Burgesses on the Parliamentary Register - - - -	565

The Small Tenements Act is in force in some of the Parishes.

The Gross Estimated Rental—	£
In 1856 was - - - -	27,738
The present Gross Estimated Rental is - - - -	33,395
Increase - - -	5,657

The Rateable Value—	£	
In 1856 was - -	23,761	Increase since 1856
The present Rateable Value is - - -	26,567	£2,806

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	33,868
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	32,577

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	204
£6 and under £7 - - -	94
£7 and under £8 - - -	136
£8 and under £9 - - -	110
£9 and under £10 - - -	81
£10 and over - - -	795
	1,420

At a Rateable Value of—	
£4 and under £5 is - - -	92
£5 and under £6 - - -	101
£6 - - - - -	140
Above £6 and under £7 - -	42
£7 and under £8 - - -	89
£8 and under £9 - - -	127
£9 and under £10 - - -	75
£10 and over - - - -	643

The Gross Estimated Rental it is stated is supposed to represent the full rack rent. In some cases it is above and in others below the rent paid.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parish of Whippingham; from 12½ to 15 per cent. in the Parish of Carisbrooke; and from 10 to 15 per cent. in the Parish of St. Nicholas. In the Parish of Newport the deduction is said to be "not uniform."

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* The Return was forwarded to the Clerk to the Guardians with a request that the occupation of each Voter returned as belonging to the Working Class might be entered in the Register. It was stated, however, that the person who prepared the Return was very ill, and wholly unable to do so, but that the Return had been prepared with the greatest care. A large lace manufactory has for many years been established at Newport.

114. NORTHALLERTON.

Population in 1831 -	4,839	Population in 1861 -	4,755	Decrease	84
		Population in 1866 (computed) -	4,639	Decrease	200

Inhabited Houses in 1861 - 1,058

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	Qualifications not distinguished.	452	—
Voters in respect of Burgage Rights		2	—
Total - -	257	454	197

Double entries on Register of 1865–6 :—			
As £10 Occupiers - -	11	12	
As £10 Occupiers and Voters in respect of Ancient Right Qualifications - -	1		Number who voted at the last General Election.
Actual Number of Electors - -		442	429

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 137*

The Small Tenements Act appears to have been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - -	23,135
The present Gross Estimated Rental is - - - - -	34,801
Increase - -	11,666

The Rateable Value—	£	
In 1856 was - -	20,468	Increase since 1856 £9,433
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	22,298	
The present Rateable Value is - - -	29,901	since 1862 £7,603

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	27,775
The Gross Estimated Rental of the same description of Property according to the Valuation List is	27,839

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - -	446
£6 and under £7 - - -	38
£7 and under £8 - - -	20
£8 and under £9 - - -	17
£9 and under £10 - - -	10
£10 and over - - -	562
	1,093

At a Rateable Value of—	
£4 and under £5 is - - -	66
£5 and under £6 - -	55
£6 - - - - -	1
Above £6 and under £7 - -	17
£7 and under £8 - - -	12
£8 and under £9 - - -	31
£9 and under £10 - - -	69
£10 and over - - -	453

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* It is stated that many of the voters in the township of Broughton included in the Return of Working Classes are hand-loom weavers. These persons receive the material for manufacture from their employers, and work it up at their own houses with their own looms, and are paid a certain price per piece.

115. NORTHAMPTON.

Population in 1831	- 15,351	Population in 1861	- 32,813	Increase	- 17,462
		Population in 1866 (computed)	- 36,405	Increase	- 21,054

Inhabited Houses in 1861 - - - 6,150

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	—	2,579	2,579	—
Six Months Inhabitant Householders not receiving Alms -	2,497	278	—	2,219
Total - -	2,497	2,857	2,579	2,219
			Net Increase. 360	

Double entries on Register of 1865–6:—

As £10 Occupiers - -	68	237	Number who voted at the last General Election.
As £10 Occupiers and Ancient Right Qualifications - -	169		
Actual Number of Electors - -		2,620	2,284

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - -	1,151
As Voters in respect of Ancient Right Qualifications - - - -	160
Total - - -	1,311
Deduct Double entries -	62
Net Number - -	1,249*

Number of Burgesses - - - - - - -	3,867
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	1,315
Number of Burgesses on the Parliamentary Register - - -	2,113

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - -	70,236
The present Gross Estimated Rental is - - - -	117,217
Increase - -	46,981

The Rateable Value—	£	
In 1856 was - -	57,163	Increase since 1856 £39,730
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	80,085	since 1862 £16,808
The present Rateable Value is - - -	96,893	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	117,535
The Gross Estimated Rental of the same description of Property according to the Valuation List is	113,205

The Number of Male Occupiers:—

At a Gross Estimated Rental—	
Under £6 is - - -	714
£6 and under £7 - - -	525
£7 and under £8 - - - -	608
£8 and under £9 - -	993
£9 and under £10 - - -	299
£10 and over - - -	3,233
	6,372

At a Rateable Value of—	
£4 and under £5 is - - -	927
£5 and under £6 - - -	1,092
£6 - - - - -	341
Above £6 and under £7 - -	279
£7 and under £8 - - -	910
£8 and under £9 - - -	349
£9 and under £10 - - -	396
£10 and over - - -	1,869

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of *5s.* in the pound is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £10, and *6s.* in the pound in the case of Houses under £10.

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* The large number of the Working Classes on the Register is attributed to the number of shoemakers in Northampton.

116. NORWICH.

Population in 1831	61,116	Population in 1861	74,891	Increase	13,775
		Population in 1866 (computed)	78,185	Increase	17,069

Inhabited Houses in 1861 - - - 17,112

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	1,043	2,439	1,396	—
Freemen	2,420	1,971	—	449
Freeholders	775	1,272	497	—
Total	4,238	5,682	1,893	449
			Net Increase. 1,444	

Double entries on Register of 1865-6 :—

As £10 Occupiers	109	865	Number who voted at the last General Election.
As £10 Occupiers and Freemen, &c.	756		
Actual Number of Electors		4,817	3,457

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	326
As Freemen	1,063
As Freeholders	266
Total	1,655
Deduct Double entries	65
Net Number	1,590

Number of Burgesses	3,383
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	58
Number of Burgesses on the Parliamentary Register	2,666

A Local Act, 26 & 27 Vict. c. 93., provides that the Owner of every Dwelling-house in the Union not exceeding the gross yearly rent or value of £9 shall be rated instead of the Occupier. There is no provision in the Act for the protection of the Municipal Franchise.

The Gross Estimated Rental—	£
In 1856 was	199,469
The present Gross Estimated Rental is	237,913
Increase	38,444

The Rateable Value—	£	
In 1856 was	143,023	Increase since 1856 £28,390
The present Rateable Value is	171,413	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	230,358
The Gross Estimated Rental of the same description of Property according to the Valuation List is	226,294

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	747
£6 and under £7	211
£7 and under £8	201
£8 and under £9	296
£9 and under £10	211
£10 and over	4,393
	6,059*

At a Rateable Value of—	
£4 and under £5 is	2,710
£5 and under £6	2,012
£6	167
Above £6 and under £7	1,340
£7 and under £8	1,235
£8 and under £9	473
£9 and under £10	625
£10 and over	3,602

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 10 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £9 and not exceeding £10. Houses of £9 and under at one third and one fourth of the respective Gross Estimated Rentals.

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* In addition to this number there are 8,684 houses of the Gross Yearly Rent or Value not exceeding £6, and 4,978 exceeding £6 and not exceeding £9. These houses, which are rated to the owners instead of the occupiers under the Local Act above referred to, are not included in the Return, as they are entered in the Rate Books in groups in aggregate sums, and the Rate Books do not afford the means of distributing them under the proper heads.

The compound houses have been, however, included under the several heads of Rateable Value upon a return furnished by Mr. Hotson, the District Auditor. In explanation of the return, Mr. Hotson states, "The cottages for which the owners are assessed have been "dealt with in the way suggested, viz., after making the usual deductions for repairs, &c. by dividing the Rateable Value of each "owner's cottages by the number, and placing the result, which would represent the average Rateable Value, under its corresponding "head, and from the numbers thus obtained deducting what appeared to me a fair allowance for female occupiers and empties."

117. NOTTINGHAM.

Population in 1831	50,220	Population in 1861	74,693	Increase	24,473
		Population in 1866 (computed)	85,200	Increase	34,980

Inhabited Houses in 1861 - - 15,441

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	2,187	4,329	3,169	—
Voters in respect of ancient right qualifications		1,027		
Freemen	3,033	1,565	—	1,468
Total	5,220	6,921	3,169	1,468
			Net Increase. 1,701	

Double entries on Register of 1865–6 :—

As £10 Occupiers	59	987	
As £10 Occupiers and Freemen or Voters in respect of ancient right qualifications	928		Actual Number of Votes recorded at the last General Election.
Actual Number of Electors		5,934	9,314

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	1,107
As Freemen	1,198
As Voters in respect of ancient right qualifications	370
Total	2,675
Deduct Double entries	333
Net Number	2,342*

Number of Burgesses	6,910
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	2,331
Number of Burgesses on the Parliamentary Register	4,031

The Small Tenements Act has been adopted.

The Gross Estimated Rental—

	£
In 1856 was	205,322
The present Gross Estimated Rental is	292,488
Increase	87,166

The Rateable Value—

	£	
In 1856 was	181,649	Increase since 1856 £75,626
In 1862 immediately before the date of the Union Assessment Committee Act it was	237,531	since 1862 £19,744
The present Rateable Value is	257,275	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	280,023
The Gross Estimated Rental of the same description of Property according to the Valuation List is	279,813

The Number of Male Occupiers :—

At a Gross Estimated Rental of—

Under £6 is	4,860
£6 and under £7	1,825
£7 and under £8	2,214
£8 and under £9	1,123
£9 and under £10	681
£10 and over	4,919
	15,622

At a Rateable Value of—

£4 and under £5 is	3,506
£5 and under £6	1,354
£6	1,773
Above £6 and under £7	450
£7 and under £8	1,819
£8 and under £9	1,456
£9 and under £10	1,035
£10 and over	4,298

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and over £9 5*s.*, and 20 per cent. in the case of Houses under £9 5*s.* and in composition.†

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* The Register was returned with a request that the occupation of the Voters who belong to the Working Class might be inserted therein, but it was stated that it would take more time than it seemed could be allowed for the purpose.

† It is stated that all property of the rent of 3*s.* 6*d.* per week, the landlord paying the rates, is considered as coming under the provisions of the Small Tenements Act, and entered at the Rateable Value of £6.

118. OLDHAM.

Population in 1831	- 50,513	Population in 1861	- 94,344	Increase	- 43,831
		Population in 1866 (computed)	- 107,729	Increase	- 57,216

Inhabited Houses in 1861 - - 18,335

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers -	1,131	2,316	1,185
Double entries on Register of 1865–6 - - -		31	Number who voted at the last General Election.
Actual Number of Electors - - -		2,285	1,993

Number of Working Classes on the present Parliamentary Register - - 315

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - -	192,594
The present Gross Estimated Rental is - - - - -	450,407
Increase - - -	257,813

The Rateable Value—	£	
In 1856 was - -	179,818	Increase since 1856 £66,050
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	220,308	since 1862 £25,560
The present Rateable Value is - - - -	245,868	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	309,250
The Gross Estimated Rental of the same description of Property according to the Valuation List is	325,369

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	4,683
£6 and under £7 - - - -	3,078
£7 and under £8 - - - -	2,849
£8 and under £9 - - -	979
£9 and under £10 - - -	255
£10 and over - - -	3,342*
	15,186

At a Rateable Value of—	
£4 and under £5 is - - -	4,888
£5 and under £6 - - - -	2,780
£6 - - - - - -	255
Above £6 and under £7 - - -	473
£7 and under £8 - - -	446
£8 and under £9 - - -	336
£9 and under £10 - - -	209
£10 and over - - -	2,278

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 33⅓ per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10. This deduction it is stated the Assessment Committee consider is not too much to cover the repairs and depreciation.

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* With reference to the number of Male Occupiers at £10 Gross Estimated Rental as compared with the number of Electors it is stated that many persons become disqualified by nonpayment of rates, and that it is possible that there may be a few cases in which Occupiers have been entered more than once when the Assistant Overseers have not been aware that they are interested in different concerns, and included in two or three different assessments. It is also stated that a great number of persons (such as small shopkeepers) disqualify themselves purposely by not paying their rates in due time.

119. OXFORD.

Population in 1831 -	20,649	Population in 1861 -	27,560	Increase -	6,911
		Population in 1866 (computed) -	27,420	Increase -	6,771

Inhabited Houses in 1861 - - - 5,234

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	904	2,162	1,258	—
Freemen - - - -	1,408	951	—	457
Total - -	2,312	3,113	1,258	457
			Net Increase. 801	

Double entries on Register of 1865–6:—

As £10 Occupiers and Freemen - -	519
Actual Number of Electors -	2,594

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - -	750
As Freemen - - - -	502
Total - -	1,252*

Number of Burgesses - - - - - - - - - -	2,939
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	None.
Number of Burgesses on the Parliamentary Register - - - -	2,219

The Small Tenements Act appears to be in force in two of the Parishes. A Local Act, 17 & 18 Vict. c. 219. sect. 39. provides that within the Parishes of the Oxford Incorporation the party letting out Houses in separate apartments or ready furnished shall be rated for the same.

The Gross Estimated Rental—	£
In 1856 was - - -	143,942
The present Gross Estimated Rental is - - - - -	131,110
Decrease - -	†12,832

The Rateable Value—	£	
In 1856 was - -	115,730	Decrease since 1856
The present Rateable Value is - - -	100,607	£15,123

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	127,498
The Gross Estimated Rental of the same description of Property according to the Poor Rate or Valuation List is - - - - - - - - - -	125,823

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	308
£6 and under £7 - - -	358
£7 and under £8 - - -	370
£8 and under £9 - - -	254
£9 and under £10 - - -	347
£10 and over - - -	2,799
	4,436

At a Rateable Value of—	
£4 and under £5 is - - -	444
£5 and under £6 - - -	553
£6 - - - - - -	342
Above £6 and under £7 - -	84
£7 and under £8 - - -	125
£8 and under £9 - - -	532
£9 and under £10 - - -	340
£10 and over - - -	2,027

The Gross Estimated Rental it is stated is believed to represent the full rack rent.

In three Parishes a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10; in three Parishes the deduction is one fourth in the case of Houses above £8, and one third for Houses under £8; in one Parish a deduction of one fifth; and in nine Parishes a deduction of one third. In one Parish there are no Houses at and under £10.

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* In this number college servants, about 200, are included.

† With reference to this decrease, it is stated that ratings have been reduced on appeal, and that within the last two years considerable property has been destroyed by fire, and other property pulled down for improvements, which at the date of the Return had not come into rating.

120. PENRYN AND FALMOUTH.

Population in 1831 - 11,881 { Population in 1861 - 14,485 Increase - 2,604
Population in 1866 (computed) - 14,918 Increase - 3,037

Inhabited Houses in 1861 - - 2,238

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	400	816	416	—
Scot and Lot Voters -	475	71	—	404
Total - -	875	887	416	404

Net Increase. 12

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	28	50
As £10 Occupiers and Scot and Lot Voters - - -	22	
Actual Number of Electors		837

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - -	250
As Scot and Lot Voters - - -	49
Total - - -	299
Deduct Double entries - -	9
Net Number - - -	290

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in Falmouth.

The Gross Estimated Rental—	£
In 1856 was - - - - -	30,934
The present Gross Estimated Rental is - - - - -	41,349
Increase - -	10,415

The Rateable Value—	£	
In 1856 was - -	24,438	Increase since 1856 £7,821
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	25,191	since 1862 £7,068
The present Rateable Value is - - -	32,259	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	42,537
The Gross Estimated Rental of the same description of Property according to the Valuation List is	39,596

The Number of Male Occupiers :—*

At a Gross Estimated Rental of—	
Under £6 is - - - - -	584
£6 and under £7 - - - - -	95
£7 and under £8 - - - -	61
£8 and under £9 - - - - -	85
£9 and under £10 - - - - -	41
£10 and over - - - -	1,266
	2,132

At a Rateable Value of—	
£4 and under £5 is - - - -	99
£5 and under £6 - - - - -	58
£6 - - - - - -	55
Above £6 and under £7 - - -	37
£7 and under £8 - - - -	150
£8 and under £9 - - - - -	85
£9 and under £10 - - - -	127
£10 and over - - - - -	897

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of new Houses at and under £10; and a deduction of from 25 to 30 per cent. in all others, except very old Houses, when 35 per cent. is deducted.

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* In Budock and Falmouth town the number of tenements in respect of which Owners are rated and not the number of Male Occupiers, is given.

121. PETERBOROUGH.

Population in 1831	6,511	Population in 1861	11,735	Increase	5,224
		Population in 1866 (computed)	13,651	Increase	7,140

Inhabited Houses in 1861 - - 2,401

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	285	609	324	—
Scot and Lot Voters and other ancient right qualifications	488	44	—	444
Total	773	653	324	444
			Net Decrease. 120	

Double entries on Register of 1865–6 :—

As £10 Occupier	1	12	Number who voted at the last General Election.
As £10 Occupiers and Scot and Lot Voters	11		
Actual Number of Electors		641	601

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	111
As Scot and Lot Voters, &c.	33
Total	144
Deduct Double entries	1
Net Number	143*

The Small Tenements Act appears to have been adopted.

The Gross Estimated Rental—	£
In 1856 was	37,940
The present Gross Estimated Rental is	59,667
Increase	21,727

The Rateable Value—	£	
In 1856 was	32,288	Increase since 1856 £19,870
In 1862 immediately before the date of the Union Assessment Committee Act it was	40,744	since 1862 £11,414
The present Rateable Value is	52,158	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	53,974
The Gross Estimated Rental of the same description of Property according to the Valuation List is	50,316

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	534
£6 and under £7	283
£7 and under £8	454
£8 and under £9	109
£9 and under £10	46
£10 and over	678
	2,104

At a Rateable Value of—	
£4 and under £5 is	306
£5 and under £6	374
£6	380
Above £6 and under £7	128
£7 and under £8	1[illegible]
£8 and under £9	96
£9 and under £10	47
£10 and over	588

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 12½ per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of new and slated or tiled Houses at and under £10, and 15 per cent. on old and thatched Buildings.

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* Peterborough it is stated is a great centre for railways. Mechanics are well to do and numerous.

122. PETERSFIELD.

Population in 1831	4,391	Population in 1861	5,655	Increase	1,264
		Population in 1866 (computed)	5,708	Increase	1,317

Inhabited Houses in 1861 - - 1,135

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	255	323	68

Double entries on Register of 1865–6:—

As £10 Occupiers	27	
Actual Number of Electors	296	No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - - 37

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	32,963
The present Gross Estimated Rental is	39,683
Increase	6,720

The Rateable Value—	£	
In 1856 was	24,079	Increase since 1856 £7,840
In 1862 immediately before the date of the Union Assessment Committee Act it was	26,361	since 1862 £5,558
The present Rateable Value is	31,919	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	37,787
The Gross Estimated Rental of the same description of Property according to the Valuation List is	34,371

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	617
£6 and under £7	44
£7 and under £8	12
£8 and under £9	13
£9 and under £10	4
£10 and over	350*
	1,040

At a Rateable Value of—	
£4 and under £5 is	38
£5 and under £6	10
£6	3
Above £6 and under £7	15
£7 and under £8	3
£8 and under £9	36
£9 and under £10	24
£10 and over	273*

The Gross Estimated Rental it is stated is supposed to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses over £6, and £25 per cent. Houses under £6.

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[*] The Return as to Male Occupiers Gross Estimated Rental was made in August 1865, and that as to Rateable Value in December 1865. In the meantime some houses of £10 and over were converted into small tenements, holdings by two or more Occupiers became incorporated and held by one, and in some cases widows became Occupiers in the place of their deceased husbands.

123. PLYMOUTH.

Population in 1831 -	31,080	Population in 1861 -	62,599	Increase -	31,519
		Population in 1866 (computed) -	68,538	Increase -	37,458

Inhabited Houses in 1861 - - 6,084

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - -	1,346	3,109	1,763	—
Freemen or Burgesses -	115	14	—	101
Total - -	1,461	3,123	1,763	101
			Net Increase. 1,662	

Double entries on Register of 1865–6:—

As £10 Occupiers - - -	173	179	Number who voted at the last General Election.
As £10 Occupiers and Burgesses	6		
Actual Number of Persons entitled to vote -		2,944	2,400

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - -	497
As Burgesses - - - - - -	1
	498
Deduct Double entries -	3
Net Number - - -	495

Number of Burgesses - - - - - - - - - -	2,816
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	15
Number who are on the Parliamentary Register - - - - - - -	2,548

The Parliamentary and Municipal boundaries are not strictly conterminous. The Parliamentary Borough comprises a tract of ground on the eastern side, and beyond the Municipal Borough reclaimed from the sea, and there are no Voters on the Register in respect of property within its limits. The Small Tenements Act has not been adopted, but there is a Local Act.

The Gross Estimated Rental—	£
In 1856 was - - - -	178,281
The present Gross Estimated Rental is - - - - -	173,530
Decrease - - -	4,751

The Rateable Value—	£	
In 1856 was - - -	115,980	Increase since 1856
The present Rateable Value is - - -	144,188	£28,208

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	175,120
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	167,801

The Number of Male Occupiers:—*

At a Gross Estimated Rental of—	
Under £6 is - - - -	113
£6 and under £7 - - -	31
£7 and under £8 - - -	39
£8 and under £9 - - -	50
£9 and under £10 - - -	54
£10 and over - - - -	3,629
	3,916

At a Rateable Value of—	
£4 and under £5 is - - - -	200
£5 and under £6 - - -	183
£6 - - - - - -	261
Above £6 and under £7 - -	53
£7 and under £8 - - -	227
£8 and under £9 - - -	396
£9 and under £10 - - -	129
£10 and over - - - -	3,228

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of about 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The larger portion of the houses in the Borough let to separate tenants are above the annual value of £10, but there are a considerable number of less annual value than £10, which are occupied by more than one tenant, and in which the landlord does not reside. A house to house visitation would be necessary to ascertain the number and value of the occupations.

124. POOLE.

Population in 1831 - 8,216	Population in 1861	9,759	Increase	1,543
	Population in 1866 (computed)	10,021	Increase	1,805

Inhabited Houses in 1861 - - 2,034

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease
£10 Occupiers	301	556	255	—
Freemen	111	12	—	99
Total	412	568	255	99
			Net Increase. 156	

Double entries on Register of 1865-6 :—			
As £10 Occupiers	39	47	Number who voted at the last General Election.
As £10 Occupiers and Freemen	8		
Actual Number of Electors		521	414

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 17*

Number of Burgesses	701
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	124
Number of Burgesses on the Parliamentary Register	552

The Small Tenements Act is in force.

The Gross Estimated Rental—	£
In 1856 was	32,207
The present Gross Estimated Rental is	28,693
Decrease	3,514

The Rateable Value—	£	
In 1856 was	21,526	Increase since 1856 £1,665
In 1862 immediately before the date of the Union Assessment Committee Act it was	23,291	
The present Rateable Value is	23,191	Decrease since 1862 £100†

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	27,900
The Gross Estimated Rental of the same description of Property according to the Valuation List is	27,727

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	943
£6 and under £7	102
£7 and under £8	21
£8 and under £9	89
£9 and under £10	12
£10 and over	616
	1,783

At a Rateable Value of—	
£4 and under £5 is	317
£5 and under £6	23
£6	—
Above £6 and under £7	117
£7 and under £8	10
£8 and under £9	152
£9 and under £10	39
£10 and over	512

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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[*] With reference to the small number of Mechanics, Artizans, &c. on the Register it is stated that the rates and taxes in Poole have been as high as 13*s.* in the pound per annum, and that in consequence persons of that class have been driven into houses at and under £6.

[†] Before the Union Assessment Committee Act came into operation only 12½ per cent. was allowed on the Gross Estimated Rental for repairs and insurance in the parishes of Poole and Longfleet. Since that period a deduction of 20 per cent. has been allowed.

125. PONTEFRACT.

Population in 1831	9,999	Population in 1861	11,736	Increase	1,737
		Population in 1866 (computed)	11,848	Increase	1,849

Inhabited Houses in 1861 - - - - 2,596

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	418	652	234	—
Scot and Lot Voters	538	80	—	458
Total	956	732	234	458
			Net Decrease. 224	

Double entries on Register of 1865–6 :—

As £10 Occupiers	28	33	
As £10 Occupiers and Scot and Lot Voters	5		Number who voted at the last General Election.
Actual Number of Electors		699	602

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	98
As Scot and Lot Voters	66
Total	164
Deduct Double entries	2
Net Number	162

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in 2 of the 7 Parishes.

The Gross Estimated Rental—	£
In 1856 was	39,626
The present Gross Estimated Rental is	42,729
Increase	3,103

The Rateable Value—	£	
In 1856 was	35,494	Decrease since 1856
The present Rateable Value is	35,275	£219

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	41,043
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is	33,629*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	1,668	£4 and under £5 is	270
£6 and under £7	67	£5 and under £6	106
£7 and under £8	63	£6	16
£8 and under £9	28	Above £6 and under £7	52
£9 and under £10	38	£7 and under £8	62
£10 and over	617†	£8 and under £9	30
		£9 and under £10	47
	2,481	£10 and over	609

In Ferryfrystone and Pontefract Park District the Gross Estimated Rental it is stated represents the full rack rent. In Carleton it does not represent the full rack rent. In the other Townships each property is assessed according to the circumstances and the judgment of the assessors.

With the exception of the Parish of Carleton, in which the deduction is 10 per cent. a deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* It is stated that the Income Tax Assessment is almost invariably higher in amount than the Poor Rate Assessment.

† With reference to the excess of Electors on the Register as £10 Occupiers (624) over the Male Occupiers at £10 Gross Estimated Rental (617) it is stated that in Knottingley some of the Householders on the Register are not represented in the Rate Book as occupying Houses at £10 Gross Estimated Rental. When the Revising Barrister holds his court the actual amount of rent amounting to £10 and upwards is proved by the evidence of some valuer or other competent person, who satisfies the Revision Court that the Occupier is entitled to be on the Register, although it does not appear so by the Rate Book.

126. PORTSMOUTH.

Population in 1831	50,389	Population in 1861	94,799	Increase	44,410
		Population in 1866 (computed)	108,705	Increase	58,316

Inhabited Houses in 1861 - - 15,819

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	1,280	4,670	3,390	—
Freemen	15	1	—	14
Total	1,295	4,671	3,390	14
			Net Increase. 3,376	

		Number who voted at the last General Election.
Double entries on Register of 1865–6 :— As £10 Occupier and Freeman	1	
Actual Number of Electors	4,670	3,662

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 1,266*

Number of Burgesses	9419
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	4698
Number of Burgesses on the Parliamentary Register	3089

The Small Tenements Act is in force.

The Gross Estimated Rental—	£
In 1856 was	195,001
The present Gross Estimated Rental is	301,372
Increase	106,371

The Rateable Value—	£	
In 1856 was	170,395	Increase since 1856 £87,120
In 1862 immediately before the date of the Union Assessment Committee Act it was	232,431	since 1862 £25,084
The present Rateable Value is	257,515	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	284,068†
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	291,932†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	2,305
£6 and under £7	2,040
£7 and under £8	2,778
£8 and under £9	1,088
£9 and under £10	1,174
£10 and over	5,849
	15,234

At a Rateable Value of—	
£4 and under £5 is	1,549
£5 and under £6	1,940
£6	2,695
Above £6 and under £7	543
£7 and under £8	1,535
£8 and under £9	1,415
£9 and under £10	553
£10 and over	4,790

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parish of Portsea, and 10 per cent. in the Parish of Portsmouth.

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* The large number of the Working Classes on the Register is accounted for by an immense number of artizans being employed in the dockyard and other public works, and the number of persons connected with the army and the navy.

† The Surveyor states that the discrepancy arises from the government property, viz. public buildings, &c. in the dockyards, fortifications, and barracks, which are assessed in one amount for a contribution in aid of the Poor Rate, not being included in his Return.

127. PRESTON.

Population in 1831	- 33,871	Population in 1861	- 82,985	Increase	- 49,114
		Population in 1866 (computed)	- 90,652	Increase	- 56,781

Inhabited Houses in 1861 - - 15,050

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.
£10 Occupiers -	Qualifications not distinguished	2,224
"Inhabitants at large" which was understood to mean "all Persons who "had resided within the "Township of Preston "for Six Months."		425
	6,352	2,649

Decrease - 3,703

Double entries on Register of 1865-6	- 87
Actual Number of Electors -	- 2,562

No Contest at the last General Election.

Number of Working Classes on the present Register:—

As £10 Occupiers - - - -	327
As "Inhabitants at large" (ancient right) -	299
Total - - -	626
Deduct Double entries - -	86
Net Number - - -	540

Number of Burgesses - - - - - - - - -	7,991
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	5,797
Number of Burgesses on the Parliamentary Register - - - - -	1,974

The Small Tenements Act is in force in the Township of Preston, which forms the greatest part of the Borough.

The Number of Burgesses before the adoption of the Act was 1,892.

The Gross Estimated Rental—	£
In 1856 was - - -	211,600
The present Gross Estimated Rental is - - - -	244,056
Increase - -	32,456

The Rateable Value—	£	
In 1856 was - -	194,235	Increase since 1856 £10,516
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	214,811	Decrease since 1862 £10,060
The present Rateable Value is - - -	204,751	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	231,445
The Gross Estimated Rental of the same description of Property according to the Valuation List is	231,629

The Number of Male Occupiers:—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is - - - -	5,040	£4 and under £5 is - - -	5,082
£6 and under £7 - - -	2,130	£5 and under £6 - - -	1,676
£7 and under £8 - - -	1,562	£6 - - - - -	458
£8 and under £9 - - -	781	Above £6 and under £7 - -	869
£9 and under £10 - - -	269	£7 and under £8 - - -	319
£10 and over - - -	2,537	£8 and under £9 - - -	247
		£9 and under £10 - - -	297
	12,319	£10 and over - - - -	2,370

The Gross Estimated Rental is stated to represent the full rack rent, with the exception that in the township of Fishwick in the case of Houses with Land it is 2½ per cent less.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.*

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* When the Landlord pays the rates out of the rent a weekly rental of 3*s.* 9*d.* represents a Gross Estimated Rental of £7 10*s.* and a Rateable Value of £6.

128. READING.

Population in 1831	15,595	Population in 1861	25,045	Increase	9,450
		Population in 1866 (computed)	27,059	Increase	11,464

Inhabited Houses in 1861 - - - - 4,859

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	1,830	1,830	—
Scot and Lot Voters	1,001	2	—	999
Total	1,001	1,832	1,830	999

Net Increase. 831

Double entries on Register of 1865–6 :—

As £10 Occupiers	61	63	
As £10 Occupiers and Scot and Lot Voters	2		
Actual Number of Electors		1,769	

Number who voted at the last General Election. 1,184

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 522*

Number of Burgesses	1,468
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	None.
Number of Burgesses on the Parliamentary Register	1,337†

The Small Tenements Act is in force in all the three Parishes. The 59 Geo. 3. c. 12. appears to have been adopted in two of them, and the limit at which the Owner is rated under it is stated to be £10.

The Gross Estimated Rental—

	£
In 1856 was	84,424
The present Gross Estimated Rental is	112,704
Increase	28,280

The Rateable Value—

	£	
In 1856 was	63,358	Increase since 1856 £29,328
In 1862 immediately before the date of the Union Assessment Committee Act it was	76,917	
The present Rateable Value is	92,686	since 1862 £15,769

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	109,449
The Gross Estimated Rental of the same description of Property according to the Valuation List is	104,934

The Number of Male Occupiers :—

At a Gross Estimated Rental of—

Under £6 is	1,459
£6 and under £7	296
£7 and under £8	463
£8 and under £9	44
£9 and under £10	61
£10 and over	2,687§
	5,010

At a Rateable Value of ‡—

£4 and under £5 is	147
£5 and under £6	393
£6	213
Above £6 and under £7	166
£7 and under £8	73
£8 and under £9	514
£9 and under £10	272
£10 and over	1,886

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* It is stated with reference to the number of the Working Classes on the Register that at the biscuit factory of Messrs. Huntley and Palmer between 600 and 700 men are employed, and at the Reading Iron Works between 400 and 500, that many men are also employed by Messrs. Sutton and Son, seedsmen, the railway engineering works, and the builders in the borough, and that a considerable proportion of them occupy houses at from £10 to £15 Rental. Houses have been built with amazing rapidity, the houses being chiefly of a Rental of £10 and upwards. The three lines of railway with branches have led to a large increase in the trade.

† The reason why the number of Burgesses is so much less than the number of Electors is stated to be that many persons obtain their one year's qualification for the Parliamentary Register who do not continue long enough to obtain their three years' qualification for the Burgess Lists, and that a large number of Occupiers of Houses are not put upon the Burgess Lists in consequence of their Rates being compounded for and paid by the Landlords.

‡ The names of the Occupiers of houses from £4 to £8 do not appear in the Rate Book as the Owners are assessed. The number of tenements and not of Male Occupiers is therefore given. Soon after the Union Assessment Committee Act came into operation returns were obtained of the names of the Occupiers, and it was found that from 10 to 15 per cent. were widows or spinsters.

§ The explanation afforded of the number of Male Occupiers at a Gross Estimated Rental of £10 being so much in excess of the number of Electors on the Register as £10 Occupiers is as follows: The returns of Gross Estimated Rental were made subsequently to the Revision of the Register by the Revising Barrister, and therefore include all new houses of £10 annual value which the Occupiers could not claim votes for in August last. At the Registration Court several persons rated at £9 Gross Estimated Rental claimed to be put on the Register, and the claims were admitted, and in consequence all houses of the same description have been raised by the Assessment Committee from £9 to £10.

129. REIGATE.

Population in 1831	3,397	Population in 1861	9,975	Increase	6,578
		Population in 1866 (computed)	14,193	Increase	10,796

Inhabited Houses in 1861 - - 1,583

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.
£10 Occupiers	152	926	774

		Number who voted at the last General Election.
Double entries on Register of 1865-6 :— As £10 Occupiers	6	
Actual Number of Electors	920	760

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 394*

Number of Burgesses	966
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	141
Number of Burgesses on the Parliamentary Register	746

The Small Tenements Act is in force.

The Gross Estimated Rental—	£
In 1856 was	47,501
The present Gross Estimated Rental is	79,093
Increase	31,592

The Rateable Value—	£	
In 1856 was	36,660	Increase since 1856 £28,085
In 1862 immediately before the date of the Union Assessment Committee Act it was	55,423	since 1862 £9,322
The present Rateable Value is	64,745	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	58,265†
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	61,337

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	81
£6 and under £7	124
£7 and under £8	34
£8 and under £9	103
£9 and under £10	162
£10 and over	970
	1,474

At a Rateable Value of—	
£4 and under £5 is	33
£5 and under £6	134
£6	89
Above £6 and under £7	33
£7 and under £8	157
£8 and under £9	199
£9 and under £10	65
£10 and over	753

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 10 to 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Borough of Reigate, and of from 20 to 25 per cent. in the Foreign of Reigate.

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* The large number of the Working Classes on the Register is accounted for by the fact that many persons are employed by the London and Brighton and South-Eastern Railway Companies at the Redhill Junction, and on the main lines and branches, and that there is an unusual number of gardeners in the Borough employed chiefly as jobbing gardeners, and of mechanics at work on the houses in course of erection.

† An assessment to Income Tax of new property, which is now being prepared, will, it is believed, amount to over £3,000.

130. EAST RETFORD.

Population in 1831 -	40,880	Population in 1861 -	47,330	Increase -	6,450
		Population in 1866 (computed) -	47,981	Increase -	7,101

Inhabited Houses in 1861 - - 10,362

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers and Freeholders - -	2,312	2,398 75	161	—
Freemen - -	138	64	—	74
Total -	2,450	2,537	161	74
			Net Increase. 87	

Double entries on Register of 1865–6:—

As £10 Occupiers - -	27	48
As £10 Occupiers and Freeholders	21	
Actual Number of Electors - -		2,489

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - -	240
As Freemen - - - -	29
As Freeholders - - - - -	10
Total - - -	279
Double entry - -	1
Net Number - -	278

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in 15 of the 85 Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was - - - - -	280,305
The present Gross Estimated Rental is - - - - -	348,458
Increase - - -	68,153

The Rateable Value—	£	
In 1856 was - -	233,495	Increase since 1856 £89,264
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	255,241	since 1862 £67,518
The present Rateable Value is - - -	322,759	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	354,559*
The Gross Estimated Rental of the same description of Property according to the Valuation List is	323,299*

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	5,053
£6 and under £7 - - - -	431
£7 and under £8 - - - -	206
£8 and under £9 - - - -	150
£9 and under £10 - - - -	164
£10 and over - - - - -	2,701
	8,705

At a Rateable Value of—	
£4 and under £5 is - - - -	1,247
£5 and under £6 - - - -	384
£6 - - - - - - - -	26
Above £6 and under £7 - -	183
£7 and under £8 - - - -	187
£8 and under £9 - - - -	140
£9 and under £10 - - - -	180
£10 and over - - - - -	2,466

In the cases of 81 Parishes the Gross Estimated Rental is stated to represent the full rack rent, and in 7 it is stated to be computed at the rents at which the hereditaments might reasonably be expected to let from year to year, free of all usual tenant's rates and taxes and tithe commutation rentcharge, if any.

In 7 Parishes a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10; in 47 Parishes a deduction of 20 per cent. for Houses at and under £7, and of 15 per cent. for Houses above £7; in 2 Parishes a deduction of 15 per cent. for Houses at and under £6, and of 10 per cent. for Houses above £6; in 29 Parishes a deduction of 20 per cent. for Houses under £6, and of 10 per cent. for Houses above £6, and in 3 Parishes a deduction of one sixth.

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* The large district comprized within this borough, which extends into several Unions, has rendered the comparison of the two assessments very difficult, and it is still uncertain whether the areas of assessment are precisely the same.

131. RICHMOND.

Population in 1831 - 4,722	Population in 1861	-	5,134	Increase -	412
	Population in 1866 (computed)	-	5,219	Increase -	497

Inhabited Houses in 1861 - - - 1,046

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	273	312	45
Voters in respect of Burgage Tenures		6	
Total - -	273	318	45

Double entries on Register of 1865–6 :—

As £10 Occupiers and Voters in respect of Burgage Tenures - - - - - -	2
Actual Number of Electors - -	316

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - 64

Number of Burgesses - - - - - - - - - -	455
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	None.
Number of Burgesses on the Parliamentary Register - - - - -	217

The Small Tenements Act appears to be adopted in one Parish only.

The Gross Estimated Rental—	£
In 1856 was - - - -	19,690
The present Gross Estimated Rental is - - - - -	25,474
Increase - - -	5,784

The Rateable Value—	£	
In 1856 was - -	16,122	Increase since 1856 £5,910
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	19,292	since 1862 £2,740
The present Rateable Value is - - - -	22,032	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	25,917
The Gross Estimated Rental of the same description of Property according to the Valuation List is	24,449

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	355
£6 and under £7 - - - -	51
£7 and under £8 - - - -	34
£8 and under £9 - - - -	33
£9 and under £10 - - -	21
£10 and over - - -	319
	813

At a Rateable Value of—	
£4 and under £5 is - - - -	72
£5 and under £6 - - - -	70
£6 - - - - -	5
Above £6 and under £7 - -	36
£7 and under £8 - - -	18
£8 and under £9 - - - -	33
£9 and under £10 - - -	11
£10 and over - - -	272

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

132. RIPON.

Population in 1831	5,700	Population in 1861	6,172	Increase	472
		Population in 1866 (computed)	6,219	Increase	519

Inhabited Houses in 1861 - - 1,382

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers Scot and Lot Voters Voters in respect of Burgage Tenures	341	349 — —	8 — —
Total	341	349	8

		Number who voted at the last General Election.
Double entry on Register	1	
Actual Number of Electors	348	328

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - 38

Number of Burgesses	775
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	309
Number of Burgesses on the Parliamentary Register	316

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was	22,861
The present Gross Estimated Rental is	23,988
Increase	1,127

The Rateable Value—	£	
In 1856 was	20,791	Increase since 1856 £1,004
In 1862 immediately before the date of the Union Assessment Committee Act it was	20,727	since 1862 £1,068
The present Rateable Value is	21,795	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	22,568
The Gross Estimated Rental of the same description of Property according to the Valuation List is	22,768

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	876
£6 and under £7	87
£7 and under £8	40
£8 and under £9	42
£9 and under £10	8
£10 and over	427
	1,480

At a Rateable Value of—	
£4 and under £5 is	174
£5 and under £6	156
£6	67
Above £6 and under £7	18
£7 and under 8	41
£8 and under £9	34
£9 and under £10	8
£10 and over	387

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 10 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and above £5, and of 20 per cent. in the case of Houses under £5.

133. ROCHDALE.

Population in 1831 -	19,041	Population in 1861	- 38,184	Increase	- 19,143
		Population in 1866 (computed)	- 43,668	Increase	- 24,627

Inhabited Houses in 1861 - - 7,705

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	687	1,442	755

Double entries on Register of 1865–6 :—

As £10 Occupiers - - - - - 84

Actual Number of Electors - - 1,358

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - - 68*

Number of Burgesses - - - - - - 5,356

Number of Burgesses whose Rates are assessed on or compounded for by the Owner None.

Number of Burgesses on the Parliamentary Register - - - 1,345

The Districts comprising the Parliamentary and Municipal Limits are Circles having the same diameter (one and a half miles), but the centres of such Circles are about 15 yards from each other. For all parochial purposes the Boundaries are conterminous.

The Gross Estimated Rental—	£
In 1856 was - - -	110,096
The present Gross Estimated Rental is - - - -	141,244
Increase - - -	31,148

The Rateable Value—	£	
In 1856 was - -	97,747	Increase since 1856 £16,743
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	99,139	since 1862 £15,351
The present Rateable Value is - - -	114,490	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	132,328
The Gross Estimated Rental of the same description of Property according to the Valuation List is	133,230

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - -	3,660
£6 and under £7 - - - -	935
£7 and under £8 - - -	700
£8 and under £9 - - -	176
£9 and under £10 - -	71
£10 and over - - -	1,858
	7,400

At a Rateable Value of—	
£4 and under £5 is - -	1,768
£5 and under £6 - - -	1,304
£6 - - - -	93
Above £6 and under £7 - -	370
£7 and under £8 - -	88
£8 and under £9 - - -	155
£9 and under £10 - -	141
£10 and over - - -	1,438

The Gross Estimated Rental on all rateable property above £10 per year is stated to represent the full rack rent, but in the case of property under £10 per annum, for which the landlord pays the rates, 20 per cent. is allowed.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the number of Working Classes on the Register it is stated that the borough is so circumscribed that many of the better class of artizans reside outside the boundary. Many of the houses in the borough are built with small rooms, and can be let at low rentals, affording separate apartments for the Occupiers, whilst a similar house with larger rooms would command such a rental as would confer the franchise.

134. ROCHESTER.

Population in 1831 - 10,585*	Population in 1861	-	16,862	Increase -	6,277
	Population in 1866 (computed)	-	17,915	Increase -	7,330

Inhabited Houses in 1861 - - - 3,074

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	550	1,225	675	—
Freemen - - -	523	374	—	149
Total - -	1,073	1,599	675	149

Net Increase. 526

Double entries on Register of 1865–6:—

As £10 Occupiers - -	22	141	Number who voted at the last General Election.
As £10 Occupiers and Freemen	119		
Actual Number of Electors -		1,458	1,221

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - -	423
As Freemen - -	145
Total - -	568
Double entries -	29
Net Number - -	539

Number of Burgesses - - - - - -	1,454
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	318
Number of Burgesses on the Parliamentary Register - - -	1,048

The 59 Geo. 3. c. 12. s. 19. appears to have been adopted in the Parish of St. Margaret with a rating limit of £15. A Local Act, 52 Geo. 3. c. 37, is in force in the Parish of Strood with a rating limit of £14, except where Houses are let at shorter periods than quarterly, or in lodgings or apartments.

The Small Tenements Act appears to be in force in 2 of the 6 Parishes.

The Gross Estimated Rental—	£
In 1856 was - - -	46,497
The present Gross Estimated Rental is - - - -	63,774
Increase - - -	17,277

The Rateable Value—	£	
In 1856 was - -	36,571	Increase since 1856 £16,147
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	43,456	since 1862 £9,262
The present Rateable Value is - - -	52,718	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	59,551
The Gross Estimated Rental of the same description of Property according to the Valuation List is -	59,936

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - -	327
£6 and under £7 - - -	251
£7 and under £8 - - -	377
£8 and under £9 - - -	279
£9 and under £10 - - -	145
£10 and over - - - -	1,477
	2,856

At a Rateable Value of—*	
£4 and under £5 is - - -	343
£5 and under £6 - - -	316
£6 - - - -	182
Above £6 and under £7 - -	217
£7 and under £8 - - -	247
£8 and under £9 - - -	393
£9 and under £10 - - -	131
£10 and over - - -	1,039

The Gross Estimated Rental it is stated is believed to represent the full rack rent.

In the Parishes of Rochester Cathedral Precincts, St. Margaret, and St. Nicholas, Chatham, a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and in the Parishes of Frindsbury and Strood a deduction of about 16 per cent. is made.

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* In the parish of Chatham the names of the Occupiers of compounded houses do not appear on the Valuation List, and the number of tenements is given.

135. RYE.

Population in 1831	7,360	Population in 1861	8,202	Increase	842
		Population in 1866 (computed)	8,038	Increase	678

Inhabited Houses in 1861 - - 1,684

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	388	388	—
Freemen	40	4	—	36
Scot and Lot Voters	382	—	—	382
Total	422	392	388	418
			Net Decrease. 30	

Double entries on Register of 1865–6:—

As £10 Occupiers	18	19	Number who voted at the last General Election.
As £10 Occupier and Freeman	1		
Actual Number of Electors		373	352

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - 53

Number of Burgesses	445
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	178
Number of Burgesses on the Parliamentary Register	194*

The Small Tenements Act has been adopted by 8 of the 9 Parishes.

The Gross Estimated Rental—	£
In 1856 was	46,606
The present Gross Estimated Rental is	52,332
Increase	5,726

The Rateable Value—	£	
In 1856 was	39,850	Increase since 1856 £5,588
In 1862 immediately before the date of the Union Assessment Committee Act it was	37,816	since 1862 £7,622
The present Rateable Value is	45,438	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	60,791
The Gross Estimated Rental of the same description of Property according to the Valuation List is	51,327†

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	540
£6 and under £7	90
£7 and under £8	169
£8 and under £9	132
£9 and under £10	53
£10 and over	345‡
	1,329

At a Rateable Value of—	
£4 and under £5 is	148
£5 and under £6	198
£6	9
Above £6 and under £7	104
£7 and under £8	62
£8 and under £9	40
£9 and under £10	19
£10 and over	276

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 15 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The disparity between the number of Burgesses and that of the Parliamentary Electors is attributed to the greater length of residence and rating requisite for acquiring the Municipal Franchise.

† It is stated that when the Assessment Committee revised and allowed the Valuation Lists they did so with the full knowledge of the Income Tax Assessment, and they considered that it was not a fair and just mode of estimating the rentals for the purpose of rating. In many instances it was observed that the rentals in the Schedule were excessive, and did not represent the value according to a just interpretation of the Parochial Assessment Act.

‡ The explanation of the difference between the number of Male Occupiers at a Gross Estimated Rental of £10 (345) and the number of Electors as £10 Occupiers (356) is as follows:—There are persons on the Register who occupy premises appearing in the Valuation Lists at Gross Estimated Rentals varying from £7 10*s.* to £9. A person has claimed to be inserted on the List of Voters, at the same time that he has complained of his assessment for the same premises at £9. Rental for the purpose of a vote, and rental with the view of rating, are practically different.

136. SALFORD.

Population in 1831	50,810	Population in 1861	102,449	Increase	51,639
		Population in 1866 (computed)	112,403	Increase	61,593

Inhabited Houses in 1861 - - 19,128

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	1,497	5,458	3,961

		Number who voted at the last General Election.
Double entries on Register of 1865–6:—		
As £10 Occupiers - - -	61	
Actual Number of Electors - -	5,397	3,706

Number of Working Classes on the present Parliamentary Register - 1,806*

Number of Burgesses - - - - - - - - 8,751

Number of Burgesses whose Rates are assessed on or compounded for by the Owner 6,028

Number of Burgesses on the Parliamentary Register - - - - 3,477

The Small Tenements Act has been adopted in two of the four Parishes. The 59 Geo. 3. c. 12. is in force throughout the Borough; in one the limit for rating the Owners is £20, in two £18 each, and in one £13.

The Gross Estimated Rental—	£
In 1856 was - - - - -	348,841
The present Gross Estimated Rental is - - - - -	401,707
Increase - - - -	52,866

The Rateable Value—	£	
In 1856 was - - -	309,276	Increase since 1856 £42,077
In 1862 immediately before the date of the Union Assessment Committee Act it was - - -	321,987	
The present Rateable Value is - - -	351,353	since 1862 £29,366

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	377,391
The Gross Estimated Rental of the same description of Property according to the Valuation List is	351,460

The Number of Male Occupiers:— ‡

At a Gross Estimated Rental of—	
Under £6 is - - - - -	6,179
£6 and under £7 - - - - -	2,061
£7 and under £8 - - - -	2,760
£8 and under £9 - - - -	1,127
£9 and under £10 - - - -	1,088
£10 and over - - - -	5,061†
	18,276

At a Rateable Value of—	
£4 and under £5 is - - -	2,283
£5 and under £6 - - - -	2,394
£6 - - - - - -	1,077
Above £6 and under £7 -	1,527
£7 and under £8 - - - -	1,080
£8 and under £9 - - -	1,058
£9 and under £10 - - -	442
£10 and over - - - -	4,270

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 10 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at £10, and 15 per cent. in the case of Houses under £10.

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* With reference to the large number of the Working Classes on the Register it is stated that in Salford the rents are much higher than in the other towns in the manufacturing district, as most of the operatives employed in the manufactories and warehouses in Manchester reside in the suburbs of that city, there not being sufficient house accommodation for them in Manchester. Many of the better-paid class of mechanics, porters in warehouses, and other operatives employed in Manchester reside in Salford, and occupy houses at rents of from 4*s.* 6*d.* a week which enables them to be placed on the Register. The clerk states that in order to make the Return as accurate as possible he employed persons to make a house-to-house visitation of the Voters on the Register.

† The explanation of the large excess of Electors over the Male Occupiers at a Gross Estimated Rental of £10 is that under the 59 Geo. 3. the rates made upon houses up to £20 are paid by the Owners, and they are rated at three fourths the sum which would have been payable by the Occupiers. The Overseers in arriving at the Gross Estimated Rental deduct the whole of the rates which would be payable by the Occupier were he rated; and where the rent is paid weekly, a further sum of 5 per cent. for cost of collection. The Revising Barrister, however, to arrive at the amount of annual rental, deducts the amount of rates actually paid, and nothing more.

‡ In the township of Salford there are houses let out in distinct tenements, but the several occupations are entered in the Rate Book, and have been included in the Return of Male Occupiers.

137. SALISBURY.

Population in 1831 - 11,672	Population in 1861	- 12,278	Increase	- 606
	Population in 1866 (computed)	- 12,601	Increase	- 929

Inhabited Houses in 1861 - - 2,344

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	539	702	163	—
Members of Corporation -	37	2	—	35
Total - -	576	704	163	35

Net Increase.
128

Double entries on Register of 1865–6 :—

As £10 Occupiers - - -	12	13	
As £10 Occupier and Member of Corporation - - -	1		Number who voted at the last General Election.
Actual Number of Electors - -		691	556

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - 73

Number of Burgesses - - - - - - - - - -	691
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	44
Number of Burgesses on the Parliamentary Register - - - - - -	593

There is a Local Act, 11 Geo. 4. c. 76., in force in the three Parishes which constitute the old City, the limit for rating the Owner being £10 yearly rent, except where Houses are let for a less period than a year, or in separate apartments or lodgings.

The Small Tenements Act is in force in the remaining two Parishes.

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was - - - -	39,183	In 1856 was - - -	30,845	Increase since 1856
The present Gross Estimated Rental is - - - - - -	43,551	The present Rateable Value is - - -	32,976	£2,131
Increase - - -	4,368			

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	42,120
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is - - - - - - - - -	42,329

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is - - - -	339	£4 and under £5 is - - -	919
£6 and under £7 - - - -	281	£5 and under £6 - - -	97
£7 and under £8 - - - -	258	£6 - - - - - -	58
£8 and under £9 - - -	90	Above £6 and under £7 - -	19
£9 and under £10 - - -	179	£7 and under £8 - - - -	30
£10 and over - - - -	813	£8 and under £9 - - -	38
		£9 and under £10 - - -	97
	1,960	£10 and over - - -	674

The Gross Estimated Rental is stated to represent the full rack rent.

In the Parishes of The Close, Fisherton Anger (part of), and Milford (part of), a deduction of from 10 to 30 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10. In the Parishes of St. Edmund, St. Martin, and St. Thomas, Salisbury, the Rateable Value of Tenements up to 2*s.* 6*d.* weekly rent, or gross 6*l.* 10*s.* per annum, is one fourth of the Gross Estimated Rental; above 2*s.* 6*d.* one half of two thirds of the Gross Estimated Rental; and in both cases one half of the remainder.

138. SANDWICH.

Population in 1831 -	12,183	Population in 1861 -	13,750	Increase -	1,567
		Population in 1866 (computed) -	14,301	Increase -	2,118

Inhabited Houses in 1861 - - - 2,672

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	487	841	354	—
Freemen - - - -	429	228	—	201
Total - -	916	1,069	354	201
			Net Increase. 153	

Double entries on Register of 1865–6 :—

As £10 Occupiers and Freemen - -	15	Number who voted at the last General Election.
Actual Number of Electors - -	1,054	876

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	77
As Freemen - - - - -	78
Total - - - -	155
Deduct double entries - -	13
Net Number - - -	142

The Small Tenements Act is in force in several of the Parishes of the Borough.

The Gross Estimated Rental—	£
In 1856 was - - -	38,776
The present Gross Estimated Rental is - - - - -	47,703
Increase - - -	8,927

The Rateable Value—	£	
In 1856 was - -	28,312	Increase since 1856 £9,470
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	36,152	
The present Rateable Value is - - -	37,782	since 1862 £1,630

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	50,656
The Gross Estimated Rental of the same description of Property according to the Valuation List is	46,429

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	570
£6 and under £7 - - -	286
£7 and under £8 - - -	185
£8 and under £9 - - -	148
£9 and under £10 - - -	61
£10 and over - - -	943
	2,193

At a Rateable Value of—	
£4 and under £5 is - - -	424
£5 and under £6 - - -	210
£6 - - - - -	118
Above £6 and under £7 - -	123
£7 and under £8 - - -	76
£8 and under £9 - - -	116
£9 and under £10 - - -	110
£10 and over - - -	655

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 20 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

139. SCARBOROUGH.

Population in 1831 -	8,760	Population in 1861 -	18,377	Increase -	9,617
		Population in 1866 (computed) -	21,921	Increase -	13,161

Inhabited Houses in 1861 - - 3,940

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - -	Qualifications not distinguished.	1,437	
Freemen - - -		9	
Total - -	431	1,446	1,015

Double entries on Register of 1865-6:—

As £10 Occupiers - -	89	95	Number who voted at the last General Election.
As £10 Occupiers and Freemen -	6		
Actual Number of Electors - - -		1,351	1,158

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - - 556*

Number of Burgesses - - - - - - - - -	2,361
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	2,056
Number of Burgesses on the Parliamentary Register - - - - - -	1,222

The Small Tenements Act is in force in the greater part of the Borough.

The Gross Estimated Rental—	£
In 1856 was - - - - -	59,081
The present Gross Estimated Rental is - - - - -	109,104
Increase - - -	50,023

The Rateable Value—	£	
In 1856 was - -	47,836	Increase since 1856 £40,360
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	67,026	since 1862 £21,170
The present Rateable Value is - - - -	88,196	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	105,163
The Gross Estimated Rental of the same description of Property according to the Valuation List is	104,112

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - -	1,507
£6 and under £7 - - -	274
£7 and under £8 - - -	232
£8 and under £9 - - - -	95
£9 and under £10 - - - -	137
£10 and over - - -	1,965†
	4,210

At a Rateable Value of—	
£4 and under £5 is - - -	492
£5 and under £6 - -	323
£6 - - - - - - -	56
Above £6 and under £7 - -	101
£7 and under £8 - - -	124
£8 and under £9 - - -	286
£9 and under £10 - - -	151
£10 and over - - -	1,562

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and 15 per cent. in the case of Houses with Land.

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* With regard to the number of Working Classes on the Register, it is stated that the Return represents as nearly as possible that class of persons whose living is (one way or another) earned by daily manual labour. In some cases the means of living may be extended by the employment of a very small amount of capital,—no more, in fact, than a skilled artizan would in several trades have invested in his working tools.

† It is stated with reference to the excess of Male Occupiers at £10 Gross Estimated Rental over the number of Electors on the Register as £10 Occupiers, that a very large number are excluded from the Register by nonpayment of rates, or not having resided for the requisite period. Some are excluded from indifference as to whether they have a vote or not, or from neglect to appear and defend their qualification when impeached.

140. SHAFTESBURY.

Population in 1831	8,969	Population in 1861	8,983	Increase	14
		Population in 1866 (computed)	8,780	Decrease	189

Inhabited Houses in 1861 - - - 1,928

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	296	476	180	—
Scot and Lot Voters	338	30	—	308
Total	634	506	180	308
			Net Decrease. 128	

Double entries on Register of 1865–6 :—

As £10 Occupiers	30	45
As £10 Occupiers and Scot and Lot Voters	15	
Actual Number of Electors		461

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	91
As Scot and Lot Voters	18
Total	109
Deduct double entries	7
Net Number	102

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in 6 out of the 13 Parishes.

The Gross Estimated Rental—	£
In 1856 was	43,148
The present Gross Estimated Rental is	49,508
Increase	6,360

The Rateable Value—	£	
In 1856 was	37,300	Increase since 1856 £7,400
In 1862 immediately before the date of the Union Assessment Committee Act it was	38,465	since 1862 £6,235
The present Rateable Value is	44,700	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	51,827
The Gross Estimated Rental of the same description of Property according to the Valuation List is	48,904

The Number of Male Occupiers :—

At a Gross Estimated Rental—	
Under £6 is	963
£6 and under £7	58
£7 and under £8	35
£8 and under £9	34
£9 and under £10	20
£10 and over	452
	1,562

At a Rateable Value of—	
£4 and under £5 is	128
£5 and under £6	38
£6	14
Above £6 and under £7	26
£7 and under £8	20
£8 and under £9	36
£9 and under £10	14
£10 and over	410

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in all the Parishes comprised in the Borough, except in the Parish of Donhead St. Mary, where a deduction of 25 per cent. is made in the case of Cottages and Houses.

141. SHEFFIELD.

Population in 1831	91,692	Population in 1861	185,172	Increase	93,480
		Population in 1866 (computed)	216,620	Increase	124,928

Inhabited Houses in 1861 - - 38,652

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	3,508	9,136	5,628

		Number who voted at the last General Election.
Double entries on Register of 1865–6:—		
As £10 Occupiers - - - -	579	
Actual Number of Electors - -	8,557	5,911

Number of Working Classes on the present Parliamentary Register - - 2,224*

Number of Burgesses - - - - - - - 23,091

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - None.

Number of Burgesses on the Parliamentary Register - - - - 7,937

The Small Tenements Act is not in force.

The Gross Estimated Rental—	£
In 1856 was - - -	478,334
The present Gross Estimated Rental is - - - -	702,579
Increase - -	224,245

The Rateable Value—	£	
In 1856 was - -	356,473	Increase since 1856 £172,557
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	456,236	since 1862 £72,794
The present Rateable Value is - - -	529,030	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	664,043
The Gross Estimated Rental of the same description of Property according to the Valuation List is	638,628

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	12,148
£6 and under £7 - - -	9,335
£7 and under £8 - - -	3,224
£8 and under £9 - - -	2,055
£9 and under £10 - - -	1,572
£10 and over - - - -	10,160
	38,494

At a Rateable Value of—	
£4 and under £5 is - - -	11,777
£5 and under £6 - - -	6,360
£6 - - - - -	1,067
Above £6 and under £7 - -	1,719
£7 and under £8 - - - -	1,803
£8 and under £9 - - - -	1,173
£9 and under £10 - - -	1,031
£10 and over - - -	7,153

The Gross Estimated Rental is stated to represent the full rackrent.

A deduction of about 25 per cent. on the average is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The large number of the Working Classes on the Register is attributed to the circumstance that many of the workmen of Sheffield earn large wages, and can afford to occupy houses of the value of £10 a year. It is stated that there is scarcely another Borough in which the earnings of the Working Class are so high as in Sheffield.

142. NEW SHOREHAM.

Population in 1831	25,008	Population in 1861	32,622	Increase	7,614
		Population in 1866 (computed)	33,708	Increase	8,700

Inhabited Houses in 1861 - - - 5,930

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - - -	1,035	1,906	871	—
Freeholders and Scot and Lot Voters - - - - -	890	93	—	797
Total - - -	1,925	1,999	871	797
			Net Increase. 74	

Double entries on Register of 1865–6 :—

As £10 Occupiers and Scot and Lot Voters, &c. -	21	Number who voted at the last General Election.
Actual Number of Electors - - -	1,978	1,454

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	456
As Scot and Lot Voters, &c. - -	9
Total - - - - - -	465
Double entry - -	3
Net Number - - -	462*

The Small Tenements Act is in force in 31 of the 42 Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was - - - - -	153,737
The present Gross Estimated Rental is - - - - - - -	189,984
Increase - - -	36,247

The Rateable Value—	£	
In 1856 was - - - -	123,544	Increase since 1856
The present Rateable Value is - - - -	158,489	£34,945

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	209,750
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is - - - - - - - - -	181,920

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	2,440
£6 and under £7 - - -	329
£7 and under £8 - - - -	172
£8 and under £9 - - -	189
£9 and under £10 - - - -	137
£10 and over - - - -	1,919
	5,186

At a Rateable Value of—	
£4 and under £5 is - - - - -	459
£5 and under £6 - - - - -	206
£6 - - - - - - - -	53
Above £6 and under £7 - - -	171
£7 and under £8 - - - - -	151
£8 and under £9 - - - -	219
£9 and under £10 - - - -	131
£10 and over - - - -	1,625

The Gross Estimated Rental in 29 Parishes is stated to represent the full rack rent. In one Parish it is 20 per cent. below, in one 17 per cent., and in one "considerably below." In 9 it represents the full rack rent, except in the case of Cottages at and under £6, when the Owners compound. For 1 Parish no return is made as to this point.

In 10 Parishes a deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10; in 23 Parishes the deduction is 20 per cent. for Houses above £6, and 25 per cent. for Houses below £6; in 4 Parishes 15 per cent. for Houses above £6, and 20 per cent. for Houses at and under £6; in 1 Parish from 20 to 25 per cent.; in 1 Parish about 20 per cent.; in 1 Parish 20 per cent. for Private Houses, and 25 for others; and in 1 Parish no deductions are made. For 1 Parish no return is made as to this point.

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* With reference to the number of the Working Class on the Register it is stated that in the parishes of New Shoreham and Southwick there are a large number of sailors employed in the Merchant Service and Oyster Fishery, and of labourers employed in the harbour works, and in ballasting and working among the shipping. There is also much brickmaking and building in progress at Southwick.

143. SHREWSBURY.

Population in 1831 -	21,297	Population in 1861 -	22,163	Increase -	866
		Population in 1866 (computed) -	23,519	Increase -	2,222

Inhabited Houses in 1861 - - - - 4,445

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - -	823	1,371	548	—
Freemen - - - - -	891	406	—	485
Total - - -	1,714	1,777	548	485
			Net Increase. 63	

Double entries on Register of 1865–6 :—

As £10 Occupiers - - -	50	224
As £10 Occupiers and Freemen -	174	
Actual Number of Electors - - -		1,553

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - -	327
As Freemen - - - - - -	207
Total - - - -	534
Deduct Double entries - -	37
Net Number - - -	497*

Number of Burgesses - - - - - - - -	2,495
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	933
Number of Burgesses on the Parliamentary Register - - - -	1,267

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was - - - -	80,332
The present Gross Estimated Rental is - - - - - -	91,865
Increase - - -	11,533

The Rateable Value—	£	
In 1856 was - - -	76,973	Increase since 1856
The present Rateable Value is - - -	87,549	£10,576

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	90,242
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	85,585

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	1,067
£6 and under £7 - - - -	614
£7 and under £8 - - - - -	304
£8 and under £9 - - - -	149
£9 and under £10 - - -	110
£10 and over - - - -	1,657
	3,901

At a Rateable Value of—	
£4 and under £5 is - - -	393
£5 and under £6 - - - -	511
£6 - - - - - - -	428
Above £6 and under £7 - -	400
£7 and under £8 - - -	294
£8 and under £9 - - - - -	143
£9 and under £10 - - -	127
£10 and over - - - -	1,579

The Gross Estimated Rental is stated to represent the full rack rent.

In the Parishes of St. Chad, St. Julian, Meole Brace, St. Alkmond, and Holy Cross and St. Giles a deduction of 5 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and in the Parish of St. Mary a deduction of from 5 to 10 per cent. is made.

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* With reference to the number of Working Classes on the Register it is stated that the mode of living in Shrewsbury is widely different from that in the manufacturing districts. Most married men become householders and not lodgers merely, and on the whole are much more provident than in the districts alluded to. There is no staple trade in Shrewsbury, but the persons included in the Return find employment at the various works in the town, and earn sufficient money to enable them to occupy 10*l.* houses.

144. SOUTHAMPTON.

Population in 1831 - 19,324	Population in 1861	-	46,960	Increase -	27,636
	Population in 1866 (computed)	-	54,159	Increase -	34,835

Inhabited Houses in 1861 - - - 7,712

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - -	1,359	4,147	2,788
Freemen or Burgesses - - Scot and Lot Voters - - -	44	83	39
Total - -	1,403	4,230	2,827

Double entries on Register of 1865-6 :—			
As £10 Occupiers - -	30	41	Number who voted at the last General Election.
As £10 Occupiers and Freemen, &c.	11		
Actual Number of Electors - - -		4,189	3,382

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - -	2,086
As Scot and Lot Voters - - - - -	5
Total - - - - -	2,091
Deduct Double entries - -	7
Net Number - - -	2,084*

Number of Burgesses - - - - - - - -	3,904
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	751
Number of Burgesses on the Parliamentary Register - - - - - -	2,869

A Local Act, 13 Geo. 3. c. 50. sect. 25., is in force authorizing the rating of the Owners of Houses let out in separate apartments and distinct tenements, or let ready furnished to lodgers.

The Small Tenements Act is in force in 6 of the 7 Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was - - -	187,153
The present Gross Estimated Rental is - - - - -	218,821
Increase - - -	31,668

The Rateable Value—	£	
In 1856 was - -	128,728	Increase since 1856 £40,734
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	145,608	
The present Rateable Value is - - -	169,462	since 1862 £23,854

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	202,880
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is - - - - - - - - -	200,566

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - -	34
£6 and under £7 - - -	64
£7 and under £8 - - - - -	152
£8 and under £9 - - -	75
£9 and under £10 - - - -	397
£10 and over - - - -	6,554
	7,276

At a Rateable Value of—†	
£4 and under £5 is - - -	202
£5 and under £6 - - -	390
£6 - - - - -	1,411
Above £6 and under £7 - -	35
£7 and under £8 - - - -	132
£8 and under £9 - - -	540
£9 and under £10 - - -	370
£10 and over - - - -	4,522

The Gross Estimated Rental is stated to represent the full rack rent.

In the Town of Southampton the Guardians in determining the Rateable Value are guided by a scale of weekly rents, for instance, tenements let at a weekly rental of 3*s.* and under 3*s.* 6*d.* are assessed at £5 Rateable Value, at 3*s.* 6*d.* and under 4*s.* at £6. Tenements of £10 Gross Estimated Rental are invariably assessed at £6 Rateable Value. In the tithing of Portswood a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value for Houses above £6, and 25 per cent. for Houses at £6 and under.

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* The large number of the Working Classes on the Register is attributed to the existence of the docks, railways, and manufactories in the Borough, and to the interest exhibited by the political parties to secure for the Working Classes the franchise. The Register was returned with a request that the occupations of the Voters might be inserted therein, but it was stated by the Clerk to the Guardians that to do so would involve considerable expense, and entail going over the whole of the work again. He at the same time most confidently vouched for the accuracy of the Return in every particular.

† The Clerk to the Guardians states that the rule adopted by the Guardians who under a Local Act make the Poor Rates is to bring under the operation of the Small Tenements Act all houses of the yearly rent of £10. The reason the Guardians have extended the operation of the Small Tenements Act to houses of as high a value as £10 per annum is, that such a vast number of the occupants were excused the payment of the rates that this class of property was exempted from the payment of rates altogether.

145. SOUTH SHIELDS.

Population in 1831	18,756	Population in 1861	35,239	Increase	16,483
		Population in 1866 (computed)	38,863	Increase	20,107

Inhabited Houses in 1861 - - - 4,443

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers	475	1,211	736

Double entries on Register of 1865–6 :—

As £10 Occupiers	98
Actual Number of Electors	1,113

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - - 260

Number of Burgesses	2,300
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	1,129
Number of Burgesses on the Parliamentary Register	1,170

The Act is in force throughout the whole Borough.

The Gross Estimated Rental—	£
In 1856 was	76,793
The present Gross Estimated Rental is	110,368
Increase	33,575

The Rateable Value—	£	
In 1856 was	57,411	Increase since 1856 £26,550
In 1862 immediately before the date of the Union Assessment Committee Act it was	78,678	since 1862 £5,283
The present Rateable Value is	83,961	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	88,037
The Gross Estimated Rental of the same description of Property according to the Valuation List is	75,655

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	4,552
£6 and under £7	1,137
£7 and under £8	236
£8 and under £9	360
£9 and under £10	180
£10 and over	1,271
	7,736

At a Rateable Value of—	
£4 and under £5 is	1,486
£5 and under £6	761
£6	1,566
Above £6 and under £7	1,076
£7 and under £8	223
£8 and under £9	349
£9 and under £10	206
£10 and over	1,193

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and when compounded for under Small Tenements Act the landlord is charged upon one half of the Rateable Value.

146. SOUTHWARK.

Population in 1831 -	134,117	Population in 1861 -	193,593	Increase -	59,476
		Population in 1866 (computed) -	204,872	Increase -	70,755

Inhabited Houses in 1861 - - 25,659

Number of Electors on Parliamentary Register:—

	1823–3.	1865–6.	Increase.
£10 Occupiers - -	Qualifications not distinguished.	11,575	
Voters in respect of ancient rights - - -		71	
Total - - -	4,775	11,646	6,871

Double entries on Register of 1865–6 :—

As £10 Occupiers and Voters in respect of ancient rights - - - - -	15	No Contest at the last General Election.
Actual Number of Electors - - -	11,631	

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - 5,515

Local Acts for rating Owners instead of Occupiers are in force in the following Parishes :—

Bermondsey. 49 Geo. 3. c. 184., with a rating limit of £15 yearly rent or value, except where premises are let in parcels or separate apartments, or to weekly or monthly tenants.

Christchurch. 51 Geo. 3. c. 32., with a rating limit of £20 yearly rent or value, except where houses are let to weekly or monthly tenants, or in separate apartments, or at rents payable at any shorter period than quarterly.

Rotherhithe. 10 Geo. 4. c. 131., with a rating limit of £15 yearly rent or value, except where houses are let furnished or in lodgings, or in separate apartments, or let to weekly or monthly tenants, or at rents payable at any shorter period than quarterly.

St. George the Martyr. 50 Geo. 3. c. 45., with a rating limit of £20 yearly rent or value, except where houses are let in separate apartments, and at rents payable at any shorter period than quarterly, or let to weekly or monthly tenants.

St. John, Horsleydown. 5 Geo. 4. c. 74., limited to houses let for any less term than one year at reserved rents, or at rents collected at any shorter period than quarterly.

St. Saviour. 48 Geo. 3. c. 9., with a rating limit of £20 yearly rent, except where houses are let to any weekly or monthly tenants, or in separate apartments, and at rents payable at any shorter period than quarterly.

The Gross Estimated Rental	£
In 1856 was - - - - -	676,947
The present Gross Estimated Rental is - - - - - -	909,560
Increase - -	232,613

The Rateable Value—	£	
In 1856 was - -	536,290	Increase since 1856 £166,544
The present Rateable Value is - - - -	702,834	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	801,588
The Gross Estimated Rental of the same description of Property according to the Valuation List is	740,476

The Number of Male Occupiers :—

——	At a Gross Estimated Rental of								At a Rateable Value of							
	Under £4.	£4 and under £5.	£5 and under £6.	£6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.	£4 and under £5.	£5 and under £6.	£6.	Above £6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.
Rotherhithe - -	2	47	173	158	226	333	399	2,313	634	238	179	44	75	129	82	868
St. George the Martyr	21	35	220	321	403	427	420	4,931	276	345	298	308	399	266	320	4,348
St. Olave Union - -	—	1	7	27	44	40	29	1,346	7	27	19	25	63	21	37	1,293
St. Mary Magdalen, Bermondsey - -	4	21	56	189	223	356	335	7,061	652	750	385	5	370	580	764	4,291
St. Saviour's Union -	—	1	2	11	34	33	37	1,998	21	39	30	—	13	14	13	1,752
TOTAL - -	27	105	458	706	930	1,189	1,220	17,649	1,590	1,399	911	382	920	1,010	1,216	12,552

Rotherhithe Parish.—The Gross Estimated Rental in the case of compounded tenements, of which there are a very large number, represents the full rack rent paid by the tenant, inclusive of the tenant's rates, for which the landlord is assessed. The Rateable Value of that class of houses is the value in respect of which the landlord is charged.

There are 1,426 houses of £10 Gross Estimated Rental for which the landlords are assessed. Not more than six compound occupiers are placed on the Parliamentary Register. There are generally from four to six claims each year, but the claimants do not attend the Revising Barrister's Court, and are consequently not put upon the List. In most cases of compounded properties the house is let to one tenant, who sublets portions to lodgers.

St. George-the-Martyr Parish.—The Gross Estimated Rental represents the full annual value. A deduction of one fifth is made from the Gross Estimated Rental in fixing the Rateable Value. A further deduction of about one third is made in the case of houses compounded for.

There are 4,293 compounded houses. It is the practice to send persons to all the houses rated to Owners at 5*s.* per week rental or upwards to ascertain the names of Male Occupiers who have resided 12 months previously to the 21st July in each year. Those names are placed on the list of Voters, and vary from 1,500 to 2,000 upon lists of from 3,600 to 4,200 names.

There are a few houses let out in distinct tenements.

St. Olave's Union.—Comprising the parishes of St. John, St. Olave, and St. Thomas. The Gross Estimated Rental represents the full rack rent. A deduction of 25 per cent. is allowed in arriving at the Rateable Value. In the case of compounded houses a further deduction of 20 per cent. is made in the parish of St. John, of 25 per cent. in the parish of St. Thomas, and of 45 per cent. in the parish of St. Olave.

There are 202 compounded houses above £10 Gross Estimated Rental. Only one compound occupier is on the Register.

There are houses let out in distinct tenements, but the number cannot be ascertained without a house to house visitation.

St. Mary Magdalen, Bermondsey, Parish.—The Gross Estimated Rental represents the full rack rent when the houses are not compounded for. In the case of compounded houses the composition is at £1 for every 1*s.* per week rent paid. The Rateable Value represents the reduced value in respect of which the landlord is charged. When the rates are compounded for the occupier's name appears on the Rate Book, and the Male Occupants of such houses are annually placed on the Register of Voters, provided the landlords have complied with the requirements of the Statutes for the Registration of Voters. The number of Voters upon the year's Register is 5,351. There are 4,383 Male Occupiers of compounded property rated at and above £10, and it is estimated that about 4,000 are on the Register. These Occupiers, generally speaking, belong to the Working Classes, and they have been included as such in the Return.

1,050 persons are disqualified by non-payment of assessed taxes. The only building let out in separate tenements is the Metropolitan Lodging-house. It contains 108 sets of rooms; the occupants are not on the list of Voters.

St. Saviour's Union.—Including the parishes of St. Saviour and Christchurch.

In the parish of St. Saviour in the case of compounded houses the Gross Estimated Rental is the rent paid by the tenant, the landlord paying rates, &c. In Christchurch one third is deducted for rates. One half is deducted from the Gross Estimated Rental in fixing the Rateable Value in the parish of St. Saviour; and one third in the parish of Christchurch.

There are 1,068 compounded houses above £10 Gross Estimated Rental, and 350 Occupiers of such houses are on the Register.

147. STAFFORD

Population in 1831	7,583	Population in 1861	12,532	Increase	4,949
		Population in 1866 (computed)	12,899	Increase	5,316

Inhabited Houses in 1861 - - 2,241

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	193	666	473	—
Freemen	983	973	—	10
Total	1,176	1,639	473	10
			Net Increase. 463	

Double entries on Register of 1865–6 :—

As £10 Occupiers	9	99	Number who voted at the last General Election.
As £10 Occupiers and Freemen	90		
Actual Number of Electors		1,540	1,253

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	85
As Freemen	834
Total	919
Deduct Double entries	31
Net Number	888

Number of Burgesses	1,411
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	35
Number of Burgesses on the Parliamentary Register	794

The Small Tenements Act appears to be in force in one of the two Parishes which forms about one ninth of the whole Borough.

The Gross Estimated Rental—	£
In 1856 was	26,211
The present Gross Estimated Rental is	34,980
Increase	8,769

The Rateable Value—	£	
In 1856 was	23,583	Increase since 1856 £5,560
In 1862 immediately before the date of the Union Assessment Committee Act it was	23,020	since 1862 £6,123
The present Rateable Value is	29,143	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	35,169
The Gross Estimated Rental of the same description of Property according to the Valuation List is	33,867

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	535
£6 and under £7	564
£7 and under £8	313
£8 and under £9	174
£9 and under £10	83
£10 and over	783
	2,452

At a Rateable Value of—	
£4 and under £5 is	245
£5 and under £6	673
£6	—
Above £6 and under £7	303
£7 and under £8	170
£8 and under £9	111
£9 and under £10	49
£10 and over	543

The Gross Estimated Rental it is stated represents as far as practicable the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

148. STAMFORD.

Population in 1831	7,062	Population in 1861	8,047	Increase	985
		Population in 1866 (computed)	7,638	Increase	576

Inhabited Houses in 1861 - - 1,636

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Decrease.
£10 Occupiers and Scot and Lot Voters	851	484 43	
Total	851	527	324

Double entries on Register of 1865–6 :—

As £10 Occupiers	13	15
As £10 Occupiers and Scot and Lot Voters	2	
Actual Number of Electors		512

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	87
As Scot and Lot Voters	38
Total	125

Number of Burgesses	940
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	*
Number of Burgesses on the Parliamentary Register	470

* Owners not assessed under Small Tenements Act or any Local Act.

The Gross Estimated Rental—	£
In 1856 was	23,985
The present Gross Estimated Rental is	28,249
Increase	4,264

The Rateable Value—	£	
In 1856 was	21,053	Increase since 1856 £3,072
In 1862 immediately before the date of the Union Assessment Committee Act it was	21,402	since 1862 £2,723
The present Rateable Value is	24,125	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	28,817
The Gross Estimated Rental of the same description of Property according to the Valuation List is	26,357†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	615
£6 and under £7	51
£7 and under £8	38
£8 and under £9	55
£9 and under £10	10
£10 and over	447‡
	1,216

At a Rateable Value of—	
£4 and under £5 is	142
£5 and under £6	83
£6	27
Above £6 and under £7	36
£7 and under £8	25
£8 and under £9	56
£9 and under £10	7
£10 and over	418

The Gross Estimated Rental is stated to represent generally the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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† It is stated that where landlords pay the rates on small tenements they do not pay so high a rate as the Income Tax Assessment. Also that there are many complaints that the latter assessment is too high, and that handbills have been issued on the subject.

‡ With reference to the difference between the number of Electors on the Register as £10 Occupiers and the number of Male Occupiers at £10 Gross Estimated Rental, it is stated that there are a few houses where under peculiar circumstances the tenants actually pay £10 Rent, although the various committees formed to assist the overseers in making out the Valuation Lists could not conscientiously say that such houses could be let for that sum if they were now to become unoccupied.

149. STOKE-UPON-TRENT.

Population in 1831	51,589	Population in 1861	101,207	Increase	49,618
		Population in 1866 (computed)	111,072	Increase	59,483

Inhabited Houses in 1861 - 19,855

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers	1,349	3,204	1,855

Double entries on Register of 1865–6 :—

		Number who voted at the last General Election.
As £10 Occupiers	15	
Actual Number of Electors (No Double entries on Register.)	3,189	2,690

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	859
Deduct Double entry	1
Net Number	858*

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—

	£
In 1856 was	216,226
The present Gross Estimated Rental is	293,832
Increase	77,606

The Rateable Value—

	£	
In 1856 was	182,147	Increase since 1856 £77,460
The present Rateable Value is	259,607	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	300,024†
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is	246,008†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	7,603
£6 and under £7	4,626
£7 and under £8	1,814
£8 and under £9	684
£9 and under £10	444
£10 and over	3,419
	18,590

At a Rateable Value of—	
£4 and under £5 is	3,988
£5 and under £6	5,107
£6	293
Above £6 and under £7	1,469
£7 and under £8	730
£8 and under £9	439
£9 and under £10	194
£10 and over	2,947

In the Parish of Stoke-upon-Trent the Gross Estimated Rental is stated to represent the full rack rent. In the Townships of Burslem and Tunstal the Gross Estimated Rental of Houses of £6 and under is 5 per cent., and that of Houses above £6 7½ per cent., less than the full rack-rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* It is stated that some of the persons included in the Return keep beerhouses and small shops, but in these cases the men are actually at work at their trade whilst the wife attends to the shop.

† With reference to the difference in these amounts it is stated as follows: "The Parochial Returns are made upon a relative valuation of the several properties in the several parishes made upon actual new survey by the Assessment Committee, whereas the Returns furnished by the Inland Revenue are made upon the actual rental paid by the several parties in occupation."

150. STOCKPORT.

Population in 1831	41,000	Population in 1861	54,681	Increase	13,681
		Population in 1866 (computed)	55,109	Increase	14,109

Inhabited Houses in 1861 - - - 11,255

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	1,012	1,391	379

		Number who voted at the last General Election.
Double entries on Register of 1865–6	43	
Actual Number of Persons entitled to vote	1,348	1,294

Number of Working Classes on the present Parliamentary Register - - 124*

Number of Burgesses - - - - - - - 2,798

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - None

Number of Burgesses on the Parliamentary Register - - - - - 963

The Small Tenements Act is not in force.

The Gross Estimated Rental—	£
In 1856 was	144,558
The present Gross Estimated Rental is	160,279
Increase	15,721

The Rateable Value—	£	
In 1856 was	111,562	Increase since 1856 £22,591
In 1862 immediately before the date of the Union Assessment Committee Act it was	114,845	
The present Rateable Value is	134,153	since 1862 £19,308

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	153,169
The Gross Estimated Rental of the same description of Property according to the Valuation List is	148,568

The Number of Male Occupiers:—†

At a Gross Estimated Rental of—	
Under £6 is	4,605
£6 and under £7	1,630
£7 and under £8	585
£8 and under £9	279
£9 and under £10	158
£10 and over	1,695
	8,952

At a Rateable Value of—	
£4 and under £5 is	1,508
£5 and under £6	1,540
£6	120
Above £6 and under £7	617
£7 and under £8	268
£8 and under £9	46
£9 and under £10	393
£10 and over	1,339

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the number of the Working Classes on the Register it is stated that the rents in Stockport are fully 20 per cent. lower than in similar boroughs.

† There are very few, if any, houses let out in distinct tenements at or near £10 annual value.

151. STROUD.

Population in 1831 -	39,932	Population in 1861 -	35,517	Decrease -	4,415
		Population in 1866 (computed) -	35,019	Decrease	4,913

Inhabited Houses in 1861 - - - 8,183

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - -	1,247	1,400	153
Double entries on Register of 1865-6 - - -		44	Number who voted at the last General Election.
Actual Number of Electors - - -		1,356	1,057

Number of Working Classes on the present Parliamentary Register - - 203

The Small Tenements Act is in force in some of the Parishes.

The Gross Estimated Rental—	£
In 1856 was - - - -	119,560
The present Gross Estimated Rental is - - - - -	142,671
Increase - - - -	23,111

The Rateable Value—	£	
In 1856 was - - -	99,312	Increase since 1856 £19,237
In 1862 immediately before the date of the Union Assessment Committee Act it was - - -	100,713	since 1862 £17,836
The present Rateable Value is - - -	118,549	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	140,194
The Gross Estimated Rental of the same description of Property according to the Valuation List is	136,501

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	4,744
£6 and under £7 - - -	296
£7 and under £8 - - -	149
£8 and under £9 - - -	175
£9 and under £10 - - -	80
£10 and over - - -	1,483
	6,927

At a Rateable Value of—	
£4 and under £5 is - -	985
£5 and under £6 - - -	210
£6 - - - - -	19
Above £6 and under £7 - -	170
£7 and under £8 - - -	75
£8 and under £9 - - -	191
£9 and under £10 - - -	121
£10 and over - - -	1,252

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

152. SUNDERLAND.

Population in 1831 - 40,735 { Population in 1866 (computed) } - 96,805 Increase - 56,070

Inhabited Houses in 1861 - - - 11,188

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - -	1,378	3,468	2,090

		* Number who voted at the last General Election.
Actual Number of Electors - - - (No Double entries on Register.)	3,468	2,622

Number of Working Classes on the present Parliamentary Register - 606

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted.

The Gross Estimated Rental—

	£
In 1856 was - - - -	209,117
The present Gross Estimated Rental is - - - -	288,517
Increase - - -	79,400

The Rateable Value—

	£	
In 1856 was - -	163,841	Increase since 1856 £76,370
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	*195,756*	since 1862 *£44,455*
The present Rateable Value is - - -	240,211	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	260,492
The Gross Estimated Rental of the same description of Property according to the Valuation List is	247,941

The Number of Male Occupiers :—*

At a Gross Estimated Rental of—	
Under £6 is - - - -	6,027
£6 and under £7 - - -	1,870
£7 and under £8 - - -	1,697
£8 and under £9 - - -	809
£9 and under £10 - - -	432
£10 and over - - - -	4,657
	15,492

At a Rateable Value of—	
£4 and under £5 is - - -	2,295
£5 and under £6 - - -	2,183
£6 - - - - -	930
Above £6 and under £7 - -	1,059
£7 and under £8 - - -	611
£8 and under £9 - - -	594
£9 and under £10 - - -	189
£10 and over - - - -	4,006

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* In Sunderland parish the number of houses, and not of Male Occupiers, is given when the Owners are assessed under the Small Tenements Rating Act. The number of houses so assessed is stated to be as follows :—Rateable Value at £4 and under £6, 154; at £6, 59 ; above £6 and under £7, 70 ; at £7 and under £8, 70 ; at £8 and under £9, 100 ; at £9 and under £10, 72 ; at £10 and over, 445.

Where a tenant pays £8 10*s*. for rent and rates the tenement would be entered in the Rate Book at the Gross Estimated Rental of £7, and a tenant paying 4*s*. a week for rent and rates would be entered at about £8 Gross Estimated Rental.

153. TAMWORTH.

Population in 1831 - 7,182	Population in 1861	- 10,192	Increase	- 3,010
	Population in 1866 (computed)	- 11,060	Increase	- 3,878

Inhabited Houses in 1861 - - - - 2,103

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - -	162	529	367	—
Scot and Lot Voters - - -	424	31	—	393
Total - -	586	560	367	393
			Net Decrease. 26	

Double entries on Register of 1865–6:—

As £10 Occupiers - -	25	28	Number who voted at the last General Election.
As £10 Occupiers and Scot and Lot Voters - - -	3		
Actual Number of Electors - -		532	454

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - -	186
As Scot and Lot Voters - - - -	14
Total - - - -	200*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was - - - -	37,179	In 1856 was - - -	35,601	Increase since 1856 £6,427
The present Gross Estimated Rental is - - - - -	48,613	In 1862 immediately before the date of the Union Assessment Committee Act it was - -	40,142	
Increase - - - -	11,434	The present Rateable Value is - - -	42,028	since 1862 £1,886

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	48,037
The Gross Estimated Rental of the same description of Property according to the Valuation List is	41,116†

The Number of Male Occupiers:—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is - - - - -	1,147	£4 and under £5 is - -	209
£6 and under £7 - - - - -	35	£5 and under £6 - - - - -	102
£7 and under £8 - - - - -	52	£6 - - - - - -	14
£8 and under £9 - - - - -	55	Above £6 and under £7 - - -	51
£9 and under £10 - - - -	28	£7 and under £8 - - - - -	36
£10 and over - - - - -	548	£8 and under £9 - - - -	54
		£9 and under £10 - - - - -	44
	1,865	£10 and over - - - - -	450

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses over £6, and of 25 per cent. for Houses at and under £6.

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* Included in this number are nearly 70 gardeners. It is stated that they are not farmers. The quantity of land occupied by them is small, being from half an acre to three or four acres. The land being very productive when well managed affords a precarious livelihood for the occupiers. No doubt in the spring and summer additional labour is employed, chiefly women for weeding and labourers to assist in getting in the crops, but there is not a single one who does not work all through the year as hard as a simple labourer, keeping the regular hours, and the great majority of them are not easily to be distinguished from labourers. They would not have votes but for the circumstance that the gardens are let with the houses, thus raising the occupation to above £10.

† A re-valuation of three townships has been ordered. That for Fazeley has been received, and the Gross Estimated Rental is increased from £6,984 to £8,841. The valuation for the other two townships it is well understood will much exceed the present assessment. Steps are also being taken to obtain a re-valuation of another township.

154. TAUNTON.

Population in 1831	12,148	Population in 1861	14,667	Increase	2,519
		Population in 1866 (computed)	14,919	Increase	2,771

Inhabited Houses in 1861 - - - 2,899

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	588	843	255	—
Potwallers	361	54	—	307
Total	949	897	255	307

Net Decrease. 52

Double entries on Register of 1865–6:—

As £10 Occupiers	31	58	Number who voted at the last General Election.
As £10 Occupiers and Potwallers	27		
Actual Number of Electors		839	756

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	208
As Potwallers	30
Total	238
Double entries	4
Net Number	234

The Small Tenements Act is in force in 3 of the 5 Parishes.

The Gross Estimated Rental—	£
In 1856 was	51,478
The present Gross Estimated Rental is	54,442
Increase	2,964

The Rateable Value—	£	
In 1856 was	36,252	Increase since 1856 £9,456
In 1862 immediately before the date of the Union Assessment Committee Act it was	35,187	since 1862 £10,521
The present Rateable Value is	45,708	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	53,514
The Gross Estimated Rental of the same description of Property according to the Valuation List is	52,487

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	931
£6 and under £7	393
£7 and under £8	132
£8 and under £9	94
£9 and under £10	61
£10 and over	1,123
	2,734

At a Rateable Value of *—	
£4 and under £5 is	504
£5 and under £6	194
£6	6
Above £6 and under £7	100
£7 and under £8	79
£8 and under £9	166
£9 and under £10	47
£10 and over	861

The Gross Estimated Rental is stated to represent the full rack rent.

In three Parishes a deduction of 15 or 16 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses of from £8 to £10, and of from 18 to 20 per cent. in the case of Houses under £8, and in one Parish the deduction is 20 per cent.

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* In the Return for the parish of Taunton, St. Mary Magdalen, the number of houses, and not of Male Occupiers, is given when the Owners are rated.

155. TAVISTOCK.

Population in 1831 - 5,602	Population in 1861	- 8,857	Increase	-	3,255
	Population in 1866 (computed)	- 9,270	Increase	-	3,668

Inhabited Houses in 1861 - - 1,133

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - -	209	424	215	—
Freeholders - -	38	3	—	35
Total - - -	247	427	215	35
			Net Increase. 180	

Double entries on Register of 1865-6:—		Number who voted at the last General Election.
As £10 Occupier and Freeholder - -	1	
Actual Number of Electors - -	426	395

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - 121*

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - - -	31,271
The present Gross Estimated Rental is - - - - - -	44,203
Increase - - -	12,932

The Rateable Value—	£	
In 1856 was - - -	29,311	Increase since 1856 £11,639
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	31,832	since 1862 £9,118
The present Rateable Value is - - -	40,950	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	35,082‡
The Gross Estimated Rental of the same description of Property according to the Valuation List is	30,251‡

The Number of Male Occupiers:—†

At a Gross Estimated Rental of—	
Under £6 is - - - - - -	453
£6 and under £7 - - - - -	273
£7 and under £8 - - - - -	23
£8 and under £9 - - - - -	16
£9 and under £10 - - - - -	10
£10 and over - - - -	459
	1,234

At a Rateable Value of—	
£4 and under £5 is - - - -	73
£5 and under £6 - - - - -	250
£6 - - - - - -	14
Above £6 and under £7 - -	19
£7 and under £8 - - - - -	18
£8 and under £9 - - - - -	12
£9 and under £10 - - -	24
£10 and over - - - -	414

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 15 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses of from £6 to £10, and a deduction varying from 20 to 33 per cent. for Houses under £6, the deduction varying according to the nature and condition of the property.

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* The large number of the Working Classes on the Register is attributed to the Borough being situate in a mining district and there being three iron foundries in the town. In two or three cases persons are included as miners who also occupy a little land, but their principal support is obtained by their labour as miners.

† With reference to the properties below the value of £6, and more particularly those below £5 and £4, it is stated that it is almost impossible to make an accurate return, as there are several tenants occupying one house, in several cases a tenant of every room, without making a house-to-house visitation. The numbers given approximate tolerably near to the facts. These remarks apply but in few instances to cases where the rental is above £6.

‡ The Surveyor of Taxes states that the Clerk to the Guardians informs him that the amount given as the Gross Estimated Rental is correct, and that the amount stated by him is the correct sum assessed to the Income Tax, and that he cannot ascertain the cause of the difference unless it is that the Income Tax is charged upon a higher value than the Poor Rate Valuation.

156. TEWKESBURY.

Population in 1831 -	5,780	Population in 1861 -	5,876	Increase -	96
		Population in 1866 (computed) -	5,875	Increase -	95

Inhabited Houses in 1861 - - 1268.

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.		
£10 Occupiers - -	Qualifications not distinguished	312		
Freemen - -		21		
Freeholders - -		9		
Total - -	386	342	Decrease -	44

Double entries on Register of 1865-6:—

		Number who voted at the last General Election.
As £10 Occupiers and Freemen or Freeholders -	17	
Actual Number of Electors -	325	321

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - -	79
As Freemen - - - - -	6
Total - - -	85
Deduct double entries -	1
Net Number - -	84

Number of Burgesses - - - - - - - - - - -	656
Number of Burgesses whose Rates are assessed on or compounded for by Owner - -	340
Number who are on the Parliamentary Register - - - - - - -	279

The Small Tenements Act is in force in this Borough. The number of Burgesses before the adoption of the Act was 388.

The Gross Estimated Rental—	£
In 1856 was - - - - -	22,019
The present Gross Estimated Rental is - - - - - -	22,852
Increase - - - -	833

The Rateable Value—	£	
In 1856 was - - - -	16,669	Increase since 1856 £2,467
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	16,773	since 1862 £7,363
The present Rateable Value is - - - -	19,136	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	22,716
The Gross Estimated Rental of the same description of Property according to the Valuation List is	21,691

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	559
£6 and under £7 - - - - -	64
£7 and under £8 - - - - -	27
£8 and under £9 - - - -	18
£9 and under £10 - - - -	10
£10 and over - - - -	413
	1,091

At a Rateable Value of—	
£4 and under £5 is - - - -	279
£5 and under £6 - - -	47
£6 - - - - - - -	8
Above £6 and under £7 - - -	22
£7 and under £8 - - - -	13
£8 and under £9 - - - -	78
£9 and under £10 - - - -	33
£10 and over - - - - -	282

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

157. THETFORD.

Population in 1831 -	3,462	Population in 1861	4,208	Increase -	746
		Population in 1866 (computed) -	4,276	Increase -	814

Inhabited Houses in 1861 - - - 900

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers - -	124	232	108	—
Members of Corporation -	22	5	—	17
Total - -	146	237	108	17
			Net Increase. 91	

Double entries on Register of 1865-6 :—

As £10 Occupiers - -	8	13	
As £10 Occupiers and Members of Corporation -	5		Number who voted at the last General Election.
Actual Number of Electors - -		224	216

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - 41

Number of Burgesses - - - - - - - - - - 673

Number of Burgesses whose Rates are assessed on or compounded for by the Owner None.

Number of Burgesses on the Parliamentary Register - - - -

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—

	£
In 1856 was - - - - -	12,907
The present Gross Estimated Rental is - - - - - -	13,245
Increase - - -	338

The Rateable Value—

	£	
In 1856 was - - -	10,205	Increase since 1856 £498
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	10,319	since 1862 £384
The present Rateable Value is - - -	10,703	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	14,700
The Gross Estimated Rental of the same description of Property according to the Valuation List is	12,395

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	532
£6 and under £7 - - - - -	43
£7 and under £8 - - - -	6
£8 and under £9 - - - -	48
£9 and under £10 - - -	13
£10 and over - - - -	187
	829

At a Rateable Value of—	
£4 and under £5 is - - - -	30
£5 and under £6 - - -	14
£6 - - - -	2
Above £6 and under £7 - - - -	45
£7 and under £8 - - -	16
£8 and under £9 - - - - -	43
£9 and under £10 - - - -	13
£10 and over - - - - -	127

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses under £6, and of 20 per cent. in the case of Houses over £6.

158. THIRSK.

Population in 1831 -	4,672	Population in 1861 -	5,350	Increase -	678
		Population in 1866 (computed) -	5,366	Increase -	694

Inhabited Houses in 1861 - - 1,205

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	254	383	129

Double entries on Register of 1865–6 - - - -	3
Actual Number of Electors - - -	380

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - 89

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—	£
In 1856 was - - -	33,565
The present Gross Estimated Rental is - - - -	34,419
Increase - - -	854

The Rateable Value—	£	
In 1856 was - - -	27,847	Increase since 1856 £2,692
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	28,579	since 1862 £1,960
The present Rateable Value is - - -	30,539	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	30,818
The Gross Estimated Rental of the same description of Property according to the Valuation List is	30,232

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	560
£6 and under £7 - - -	40
£7 and under £8 - - -	33
£8 and under £9 - - -	29
£9 and under £10 - - -	22
£10 and over - - - -	385
	1,069

At a Rateable Value of—	
£4 and under £5 is - - -	66
£5 and under £6 - - - -	47
£6 - - - - -	22
Above £6 and under £7 - - -	27
£7 and under £8 - - -	37
£8 and under £9 - - -	29
£9 and under £10 - - -	29
£10 and over - - - -	340

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and 10 per cent. of Land and Houses.

159. TIVERTON.

Population in 1831	9,766	Population in 1861	10,447	Increase	681
		Population in 1866 (computed)	10,115	Increase	349

Inhabited Houses in 1861 - - 2,210

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	443	461	18	—
Members of the Corporation or Freemen	19	4	—	15
Total	462	465	18	15
			Net Increase. 3	

		Number who voted at the last General Election.
Actual Number of Electors (No Double entries on Register.)	465	441

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - 34*

Number of Burgesses	913
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	434
Number of Burgesses on the Parliamentary Register	417

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was	54,444
The present Gross Estimated Rental is	45,469
Decrease	8,975

The Rateable Value—	£	
In 1856 was	36,536	Increase since 1856 £1,172
In 1862 immediately before the date of the Union Assessment Committee Act it was	37,338	since 1862 £370
The present Rateable Value is	37,708	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	46,023
The Gross Estimated Rental of the same description of Property according to the Valuation List is	44,382

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	733
£6 and under £7	74
£7 and under £8	63
£8 and under £9	47
£9 and under £10	23
£10 and over	434
	1,374

At a Rateable Value of—†	
£4 and under £5 is	174
£5 and under £6	101
£6	32
Above £6 and under £7	33
£7 and under £8	43
£8 and under £9	45
£9 and under £10	42
£10 and over	375

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 15 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses over £6, and in the case of Houses under £6 a deduction not exceeding one third is made.

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* With reference to the number of Working Classes on the Register it is stated that the borough and parish are co-extensive, and the parish comprising about 16,800 acres a very large number of yeomen and persons engaged in agriculture are on the Register, and the average of the Working Class is less in consequence. The average wages earned in the borough is low, and the rent of small houses is also low. A very large number of those on the Register are only just above the denominated class.

† In the Return for the parish of Tiverton the number of houses, and not of Male Occupiers, is given when the owners are rated.

160. TOTNES.

Population in 1831 - 3,308	Population in 1861 -	4,001	Increase -	693
	Population in 1866 (computed) -	3,807	Increase -	499

Inhabited Houses in 1861 - - - 793

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	175	389	214	—
Freemen and Burgesses -	42	6	—	36
Total - -	217	395	214	36
			Net Increase. 178	

Double entries on Register of 1865–6 :—

As £10 Occupiers - - -	10	13	Number who voted at the last General Election.
As £10 Occupiers and Freemen -	3		
Actual Number of Electors -		382	364

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - 35

Number of Burgesses - - - - - - - -	479
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	None.
Number of Burgesses on the Parliamentary Register - - - -	280

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—

	£
In 1856 was - - - -	15,583
The present Gross Estimated Rental is - - - - -	15,890
Increase - - -	307

The Rateable Value—

	£	
In 1856 was - -	12,179	Increase since 1856 £486
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	10,721	since 1862 £1,944
The present Rateable Value is - - -	12,665	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	16,710
The Gross Estimated Rental of the same description of Property according to the Valuation List is	15,658

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	326
£6 and under £7 - - -	35
£7 and under £8 - - -	24
£8 and under £9 - - -	8
£9 and under £10 - - -	6
£10 and over - - - -	516
	915

At a Rateable Value of—	
£4 and under £5 is - - -	126
£5 and under £6 - - -	80
£6 - - - - -	35
Above £6 and under £7 - - -	27
£7 and under £8 - - -	22
£8 and under £9 - - -	33
£9 and under £10 - - -	11
£10 and over - - -	435

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 15 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6, and in the case of Cottages not exceeding £6 a deduction of one fifth or one third is made.

161. TOWER HAMLETS.

Population in 1831 - 361,783 { Population in 1861 - 647,845 Increase - 286,062

Population in 1866 (computed) - 710,179 Increase - 348,396

Inhabited Houses in 1861 - - 88,310

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	9,906	34,115	24,209

Actual Number of Electors - - 34,115
(No Double entries on Register.)

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 8,107*

Local Acts for rating Owners instead of Occupiers are in force in the following Parishes :—

Bethnal Green. 53 Geo. 3. c. 113., with a rating limit of £14 yearly rent or value, except where Houses are let at rents payable at any shorter period than quarterly, or let in lodgings or separate apartments.

Bow. 44 Geo. 3. c. 57., with a rating limit of £10 yearly rent or value, except where Houses are let to weekly or monthly tenants, or in separate apartments, and at rents payable at any shorter period than quarterly.

Bromley. 51 Geo. 3. c. 125., with a rating limit of £16 net annual rent, except as in the preceding case.

Hackney. 50 Geo. 3. c. 190., with a rating limit of £20 yearly rent or value, except where Houses are let weekly or to monthly tenants, or at rents payable at any shorter period than quarterly, or ready furnished, or in lodgings or separate apartments.

Limehouse. 49 Geo. 3. c. 39., with a rating limit of £20 yearly rent or value, except where Houses are let weekly or to monthly tenants, or at rents payable at any shorter period than quarterly, or let ready furnished, or in lodgings or separate apartments.

Mile End Old Town. 50 Geo. 3. c. 131., with a rating limit of £16 net rent, except where Houses are let to weekly or monthly tenants, or at rents payable at any shorter period than quarterly, or let in separate apartments.

Mile End New Town. 53 Geo. 3. c. 37., with a rating limit of under £20 yearly rent.

Norton Folgate. 50 Geo. 3. c. 5., with a rating limit of £20 yearly rent or value, except where Houses are let to weekly or monthly tenants, or at rents payable at any shorter period than quarterly.

Old Artillery Ground. 14 Geo. 3. c. 30., limited to premises let in parcels or separate apartments, or ready furnished.

Ratcliff. 50 Geo. 3. c. 83., with a rating limit of £15 yearly rent or value, except where Houses are let to weekly or monthly tenants, or at rents payable at any shorter period than quarterly, or let in lodgings or separate apartments, or let ready furnished.

St. Botolph without Aldgate. 51 Geo. 3. c. 153., with a rating limit of £20 yearly rent or value, except where Houses are let weekly or to monthly tenants, or at rents payable at any shorter period than quarterly, or let ready furnished, or in lodgings or separate apartments.

St. George in the East. 46 Geo. 3. c. 77., with a rating limit of £15 yearly rent or value, except where Houses are let weekly or to monthly tenants, or at rents payable at any shorter period than quarterly.

Shadwell. 50 Geo. 3. c. 208., with a rating limit of £15 yearly rent or value, except where Houses are let to weekly or monthly tenants, or to lodgers, or at rents payable at any shorter period than quarterly.

Shoreditch. 21 & 22 Vict. c. 132., with a rating limit of £15 yearly rent, except where Houses are let for any less period than one year, or let furnished or in separate apartments.

Christchurch. 47 Geo. 3. sess. 2. c. 30., with a rating limit of £15 yearly rent, except where Houses are let in separate lodgings or apartments, or ready furnished.

Wapping. 52 Geo. 3. c. 75., with a rating limit of £20 yearly rent or value, except where Houses are let to weekly or monthly tenants, or at rents payable at any shorter period than quarterly. or let ready furnished, or in lodgings or separate apartments.

Whitechapel. 16 & 17 Vict. c. 141., with a rating limit of £12 yearly value, except where Houses are let to one weekly or monthly tenant, or let furnished, or in lodgings or separate apartments.

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* The Return for Bethnal Green Parish gives 937 persons belonging to the Working Class as on the Register. It is stated that the Return can be regarded as only approximately correct. To make it perfectly accurate a house-to-house visitation would be necessary.

The Gross Estimated Rental—

	£
In 1856 was	2,231,273
The present Gross Estimated Rental is	2,769,217
Increase	537,944

The Rateable Value—

	£	
In 1856 was	1,597,795	Increase since 1856 £554,498
The present Rateable Value is	2,152,293	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	2,390,314
The Gross Estimated Rental of the same description of Property according to the Valuation List is	2,301,615

The Number of Male Occupiers:—

—	At a Gross Estimated Rental of								At a Rateable Value of							
	Under £4.	£4 and under £5.	£5 and under £6.	£6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.	£4 and under £5.	£5 and under £6.	£6.	Above £6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10,	£10 and over.
Bethnal Green, St. Matthew - -	41	91	197	657	666	1,402	643	12,652	2,455	1,845	149	1,493	1,445	1,772	911	4,919
St. George-in-the-East	—	5	80	79	184	240	312	4,843	421	502	395	348	580	887	439	2,270
Hackney, St. John -	—	8	105	138	185	308	278	12,426	26	171	86	101	222	430	259	12,153
Mile End Old Town -	—	—	8	9	995	1,007	9	9,453	981	996	1,154	810	286	68	122	7,054
Poplar Union - -	1	9	86	207	311	445	331	11,574	71	219	769	—	355	579	488	10,473
Shoreditch, St. Leonard - -	13	9	18	91	119	500	809	13,204	1,103	1,103	746	2	1,145	850	348	9,140
Stepney Union -	4	27	89	252	243	331	314	6,517	223	371	272	68	329	560	335	5,585
Whitechapel Union -	264	675	714	643	566	449	477	4,468	673	714	470	172	566	449	467	4,465
Total - -	323	824	1,297	2,076	3,269	4,682	3,173	75,137	5,953	5,921	4,041	2,994	4,928	5,595	3,369	56,009

The number of Houses included in the above Return in respect of which the Owners are assessed in lieu of the Occupiers are shown separately in the following cases:—

St. George-in-the-East	—	5	80	79	184	240	312	3,234	Houses assessed to Owners not distinguished.							
Hackney, St. John -	—	4	87	121	175	293	273	3,309	18	162	65	73	205	391	246	3,102
Mile End Old Town -	—	—	—	—	981	990	—	2,574	978	989	1,144	791	273	—	111	259
Shoreditch, St. Leonard - -	12	7	15	83	117	483	789	4,157	1,096	1,092	731	—	1,132	827	306	349
Stepney Union -	4	27	88	250	238	320	311	3,703	222	365	261	68	326	539	325	2,802
Whitechapel Union -	264	669	709	639	565	437	475	1,405	Houses assessed to Owners not distinguished.							

Bethnal Green Parish.—The Gross Estimated Rental it is stated represents the full rack rent, but for many years no attention was paid to filling up correctly the Gross Estimated Rental column in the case of compounded houses. One sixth is deducted from the Gross Estimated Rental in fixing the Rateable Value when the houses are not compounded for under the Local Act. The Rateable Value of compounded houses represents the value upon which the landlord is charged.

The number of compounded houses on a Gross Estimated Rental of £10 is 9,127, and the change of occupation is so frequent that it is impossible to get the occupiers' names on the rates. 700 compound occupiers are placed on the Register.

A house-to-house visitation would be necessary to ascertain the number of houses let out in distinct tenements. It is believed that there is no case of an occupier of a house let in separate tenements claiming to be rated.

St. George-in-the-East Parish.—The Gross Estimated Rental is stated to be the rent at which the property might be expected to let free of tenant's rates and taxes, the tenant taking those burdens upon himself. A deduction of one fifth is made from the Gross Estimated Rental in fixing the Rateable Value when the houses are not compounded for.

The Rateable Value as entered in the Rate Book in the cases in which the owners compound is the reduced value on which the owners are charged.

Very few, if any, of the occupiers of the 3,234 £10 compounded houses are at present on the Register.

The number of houses let out in distinct tenements cannot be ascertained without a house-to-house visitation.

St. John, Hackney, Parish.—The Gross Estimated Rental represents the full rack rent. One sixth is deducted from the Gross Estimated Rental in arriving at the Rateable Value when the owners do not compound. In the case of compounded houses 20 per cent. is taken off and the amount is then halved, and on that amount the landlord pays.

Of the occupiers of £10 compounded houses 69 are on the Register. From various causes, principally from a want of interest on the part of the tenants, the Compound Householders Act of 1852 has become in this parish a dead letter.

There are 16 houses above the annual value of £10 let out in distinct tenements; 15 of these are very old houses and are about to be pulled down.

Mile End Old Town Hamlet.—The Gross Estimated Rental represents the full rack rent, and a deduction of one fifth is made from the Gross Estimated Rental in fixing the Rateable Value when the owners do not compound. In the case of compounded houses the rent actually paid by the tenants, although the owner pays the rates, &c., is entered as the Gross Estimated Rental. A deduction of two fifths is made on account of repairs, &c. in arriving at the Rateable Value.

There are four or five houses let out in distinct tenements. The separate occupations would be under 50. The single rooms let for 1*s.* 9*d.* or 2*s.* per week.

Not more than 20 of the occupiers of compounded houses are on the Register. The average claims under Sir W. Clay's Act have not exceeded 5 per year during the last seven years.

Poplar Union.—The parishes comprised in this Union are Bow, Bromley, and All Saints, Poplar. The Gross Estimated Rental represents the full rack rent. A deduction of 20 per cent. is made in fixing the Rateable Value. It is stated that in this Union there are many hundreds of houses assessed to the owners. In the Parish of Poplar there are but 21 compound occupiers on the Register. The lists for Bromley and Bow do not distinguish that class of voters, but it is believed that they include but a very small number of such occupiers.

There are several houses let out in distinct tenements. The number of the separate occupations cannot be ascertained without a house-to-house visitation.

In the Parish of All Saints, Poplar, there are 4,052 houses for which the owners are rated, and of these it is estimated that one fifth are occupied by females. Only 23 of the occupiers of these houses are on the Register. The Vestry Clerk of the parish states that the average annual number of claims to be placed on the Register under Sir W. Clay's Act has not during the last 10 years exceeded 20. Not a single claim was made in 1865, and when persons have claimed they have failed to appear before the Revising Barrister to support their claims. He adds, "I am of opinion that if all persons entitled (under Sir William " Clay's Act) to be put upon the Register were to make their claim and attend to establish it, the numbers on " the Register would be increased threefold, viz. from 1,450 to 4,350; but the usual reply I receive when " I inform the claimants they will have to attend the Revising Barrister's Court is, 'Oh, I am not going to " 'lose my time to go there. If you cannot put me on the Register I shall not trouble myself any further.'"

St. Leonard, Shoreditch, Parish.—The Gross Estimated Rental represents the rent the houses would let for by the year. A deduction of one third is made from the Gross Estimated Rental in arriving at the Rateable Value. It would appear that in the Gross Estimated Rental Return persons holding more than one tenement have been entered more than once, and in some cases empty houses have been included.

Only about 50 occupiers of the 4,157 £10 compounded houses are placed on the Register.

It is believed that there are but few houses let out in distinct tenements, but a house-to-house visitation would be necessary to obtain accurate information. There are model residences for the working classes, consisting of four blocks, containing 20 sets of apartments in each. The tenants pay from 5*s.* to 7*s.* 6*d.* per week.

Stepney Union.—The parishes comprised in the Union are Limehouse, Ratcliff, Shadwell, and Wapping The Gross Estimated Rental represents the full rack rent. A deduction of 20 per cent. is made from the Gross Estimated Rental in arriving at the Rateable Value.

There are a great number of houses let out in distinct tenements, and it is estimated that about one fourth of the compound property in Limehouse (2,795 houses), one half of the compound property in Ratcliff (584 houses), and one third of the compound property in Shadwell (612 houses) and Wapping (205 houses), are let in distinct tenements. In Limehouse 10 of the owners of compounded houses are on the Register, in Ratcliff 24, but none in Shadwell and Wapping. No occupiers of houses, let out in distinct tenements, are on the Register.

Whitechapel Union.—The parishes comprised in this Union are St. Botolph, Aldgate, Christchurch, St. Katherine, Mile End New Town, Holy Trinity, Minories, Norton Folgate, the Old Artillery Ground, the Old Tower Without, and St. Mary, Whitechapel. The Gross Estimated Rental represents the full rack rent. A deduction of 15 per cent. is made from the Gross Estimated Rental in arriving at the Rateable Value.

Very few indeed of the tenements rated to the owners instead of the occupiers are occupied by one family only, but most of them by several families, by six or eight or more. Some are common lodging-houses rated to the owners, who sublet to a middleman, who lets out beds, &c., and in these great numbers of Males as well as Females reside for indefinite periods, some for a night and two, some for years. In the buildings erected by the Commissioners for improving the Dwellings of the Poor, perhaps more than a hundred Males sleep nightly in one building, while in another there are 60 or 70 families.

It is not usual in this Union to place occupiers of compounded houses on the Register. As a rule the names of the occupiers of such houses are not entered in the Rate Book. If an occupier of a compounded house should claim to be rated under Sir W. Clay's Act he would generally speaking be rated at an occupier's rating, and not on the scale on which owners are assessed.

162. TRURO.

Population in 1831 - 8,291 { Population in 1861 - 11,337 | Increase - 3,046
Population in 1866 (computed) - 11,652 | Increase - 3,361

Inhabited Houses in 1861 - - - 2,391

Number of Electors on Parliamentary Register:

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	388	639	251	—
Capital Burgesses	17	1	—	16
Total	405	640	251	16

Net Increase.
235

Double entries on Register of 1865–6 :—

As £10 Occupiers	72	73
As £10 Occupier and Capital Burgess	1	
Actual Number of Electors		567

No contest at the last General Election.

Number of Working Classes on the present Register :—
As £10 Occupiers - - - - - - 48

Number of Burgesses	1,324
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	721
Number of Burgesses on the Parliamentary Register	488

The Small Tenements Act has been adopted.

The Gross Estimated Rental :—

	£
In 1856 was	29,888
The present Gross Estimated Rental is	35,301
Increase	5,413

The Rateable Value :—

	£	
In 1856 was	20,949	Increase since 1856 £6,242
In 1862 immediately before the date of the Union Assessment Committee Act it was	21,850	
The present Rateable Value is	27,191	since 1862 £5,341

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	35,213
The Gross Estimated Rental of the same description of Property according to the Valuation List is	34,665

The Number of Male Occupiers :—

At a Gross Estimated Rental of—

Under £6 is	1,045
£6 and under £7	224
£7 and under £8	135
£8 and under £9	138
£9 and under 1 0	54
£10 and over	732
	2,328

At a Rateable Value of—

£4 and under £5 is	181
£5 and under £6	63
£6	72
Above £6 and under £7	27
£7 and under £8	160
£8 and under £9	18
£9 and under £10	66
£10 and over	499

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

163. TYNEMOUTH AND NORTH SHIELDS.

Population in 1831	23,206	Population in 1861	34,021	Increase	10,815
		Population in 1866 (computed)	36,741	Increase	13,535

Inhabited Houses in 1861 - - 4,952

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	760	1,271	511

		Number who voted at the last General Election.
Actual Number of Electors - - - (No Double entries on Register.)	1,271	932

Number of Working Classes on the present Parliamentary Register - 134

Number of Burgesses - - - - - - - - - - 2,073

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 233

Number of Burgesses on the Parliamentary Register - - - - - -

The Small Tenements Act is in force in almost all the Parishes of the Borough.

The Gross Estimated Rental—	£
In 1856 was - - - -	77,628
The present Gross Estimated Rental is - - - - -	105,848
Increase - - -	28,220

The Rateable Value—	£	
In 1856 was - -	62,827	Increase since 1856 £23,921
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	83,116	since 1862 £3,632
The present Rateable Value is - - -	86,748	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	85,965
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	82,287

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - -	3,291
£6 and under £7 - - -	251
£7 and under £8 - - -	156
£8 and under £9 - - -	265
£9 and under £10 - - -	254
£10 and over - - -	1,664
	5,881

At a Rateable Value of—	
£4 and under £5 is - - -	137
£5 and under £6	79
£6 - - - -	79
Above £6 and under £7	91
£7 and under £8 - - -	255
£8 and under £9 - - -	217
£9 and under £10 - - -	200
£10 and over - - -	1,210

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

164. WAKEFIELD.

Population in 1831 - 15,932	Population in 1861	-	23,150	Increase	- 7,218
	Population in 1866 (computed)	-	23,717	Increase	- 7,785

Inhabited Houses in 1861 - - - - 4,773

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	722	1,188	466

Double entries on Register of 1865–6 :—		Number who voted at the last General Election.
As £10 Occupiers - - -	102	
Actual Number of Electors - -	1,086	964

Number of Working Classes on the present Parliamentary Register - - 122

Number of Burgesses - - - - - - - - - - 2,165

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 351

Number of Burgesses on the Parliamentary Register (exclusive of duplicates) - 822

The Parliamentary and Municipal Boroughs are not quite conterminous, but nearly so. The Municipal Borough is rather the larger.

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - - -	69,476
The present Gross Estimated Rental is - - - - - -	85,149
Increase - - -	15,673

The Rateable Value—	£	
In 1856 was - - - -	58,602	Increase since 1856 £12,643
In 1862 immediately before the date of the Union Assessment Committee Act it was - - -	60,955	
The present Rateable Value is - - - - -	71,245	since 1862 £10,290

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	71,597
The Gross Estimated Rental of the same description of Property according to the Valuation List is	75,845

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	2,410
£6 and under £7 - - - - -	449
£7 and under £8 - - - -	198
£8 and under £9 - - - - -	93
£9 and under £10 - - - -	61
£10 and over - - - - - -	1,364
	4,575

At a Rateable Value of—	
£4 and under £5 is - - -	742
£5 and under £6 - - - -	547
£6 - - - - - -	3
Above £6 and under £7 - -	102
£7 and under £8 - - - -	63
£8 and under £9 - - -	254
£9 and under £10 - - - -	57
£10 and over - - - -	1,064

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and above £7, and of 20 per cent. in the case of Houses at £6 and under.

165. WALLINGFORD.

Population in 1831	7,352	Population in 1861	7,794	Increase	442
		Population in 1866 (computed)	7,662	Increase	310

Inhabited Houses in 1861 - - 1,657

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	287	374	87	—
Scot and Lot Voters	166	5	—	161
Total	453	379	87	161
			Net Decrease. 74	

Double entries on Register of 1865–6 :—

As £10 Occupiers	19	22	Number who voted at the last General Election.
As £10 Occupiers and Scot and Lot Voters	3		
Actual Number of Electors		357	290

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	47
Deduct double entries	2
Net Number	45

The Parliamentary and Municipal Boundaries are *not* conterminous.

The Small Tenements Act has been adopted in all the Parishes, except one, viz., All Hallows.

The Gross Estimated Rental—	£
In 1856 was	48,562
The present Gross Estimated Rental is	54,065
Increase	5,503

The Rateable Value—	£	
In 1856 was	40,472	Increase since 1856 £4,610
In 1862 immediately before the date of the Union Assessment Committee Act it was	40,065	since 1862 £5,017
The present Rateable Value is	45,082	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	45,540
The Gross Estimated Rental of the same description of Property according to the Valuation List is	45,833

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	905
£6 and under £7	79
£7 and under £8	25
£8 and under £9	24
£9 and under £10	19
£10 and over	393
	1,445

At a Rateable Value of—*	
£4 and under £5 is	179
£5 and under £6	54
£6	1
Above £6 and under £7	42
£7 and under £8	21
£8 and under £9	72
£9 and under £10	42
£10 and over	278

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* In some instances in the parishes of Benson and Brightwell the names of the Occupiers do not appear in the Valuation Lists.

166. WALSALL.

Population in 1831	14,420	Population in 1861	37,760	Increase	23,340
		Population in 1866 (computed)	45,788	Increase	31,368

Inhabited Houses in 1861 - - 7,445

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	597	1,296	699

Actual Number of Electors (No double entries on Register.)	1,296	No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - 217*

Number of Burgesses - - - - - - - - - - - - 1,470

Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him 185

Number who are on the Parliamentary Register - - - - 1,092

The Small Tenements Act has not been adopted.

The Gross Estimated Rental	£
In 1856 was	92,652
The present Gross Estimated Rental is	116,787
Increase	24,135

The Rateable Value—	£	
In 1856 was	72,238	Increase since 1856 £16,457
In 1862 immediately before the date of the Union Assessment Committee Act it was	85,224	since 1862 £3,471
The present Rateable Value is	88,695	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	101,028
The Gross Estimated Rental of the same description of Property according to the Valuation List is	100,146

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	2,629
£6 and under £7	1,266
£7 and under £8	1,068
£8 and under £9	669
£9 and under £10	409
£10 and over	1,801
	7,842

At a Rateable Value of—	
£4 and under £5 is	1,752
£5 and under £6	1,139
£6	10
Above £6 and under £7	610
£7 and under £8	425
£8 and under £9	283
£9 and under £10	222
£10 and over	1,306

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* It is stated that in Walsall there are a large number of men on the Register who are employed in the staple trade of the town (leather and saddler's ironmongery).

167. WAREHAM.

Population in 1831 - 5,596	Population in 1861	-	6,694	Increase -	1,098
	Population in 1866 (computed)	-	6,446	Increase -	850

Inhabited Houses in 1861 - - - 1,339

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - - - -	218	285	67	—
Scot and Lot Voters and Freeholders	171	13	—	158
Total - - - -	389	298	67	158
			Net Decrease. 91	

Double entries on Register of 1865–6 :—

As £10 Occupiers - - - -	14	25.	
As £10 Occupiers and Scot and Lot Voters, &c. - - - -	11		Number who voted at the last General Election
Actual Number of Electors - -		273	234

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - 56

The Small Tenements Act has been adopted in several of the Parishes.

The Gross Estimated Rental—	£
In 1856 was - - - - -	27,102
The present Gross Estimated Rental is - - - - -	27,862
Increase - - - -	760

The Rateable Value—	£	
In 1856 was - - -	20,673	Increase since 1856
The present Rateable Value is - - -	23,479	£2,806

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	26,391
The Gross Estimated Rental of the same description of Property according to the Valuation List is	27,211

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	654
£6 and under £7 - - - - -	73
£7 and under £8 - - - - -	32
£8 and under £9 - - - - -	37
£9 and under £10 - - - - -	19
£10 and over - - - -	344
	1,159

At a Rateable Value of—	
£4 and under £5 is - - -	132
£5 and under £6 - - - -	68
£6 - - - - - -	18
Above £6 and under £7 - - - -	40
£7 and under £8 - - - - -	42
£8 and under £9 - - - - -	56
£9 and under £10 - - -	47
£10 and over - - - - -	291

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

168. WARRINGTON.

Population in 1831 -	18,184	Population in 1861 -	26,947	Increase -	8,763
		Population in 1866 (computed) -	28,940	Increase -	10,756

Inhabited Houses in 1861 - - 5,146

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	456	779	323

Double entries on Register of 1865–6 :—

As £10 Occupiers - - - -	11	
Actual Number of Electors - - -	768	No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - 149

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - -	65,909
The present Gross Estimated Rental is - - - - -	86,741
Increase - - -	20,832

The Rateable Value—	£	
In 1856 was - -	59,101	Increase since 1856 £13,839
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	71,997	since 1862 £943
The present Rateable Value is - - -	72,940	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	81,186
The Gross Estimated Rental of the same description of Property according to the Valuation List is	77,647

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	2,884
£6 and under £7 - - -	619
£7 and under £8 - - -	258
£8 and under £9 - - -	258
£9 and under £10 - - -	111
£10 and over - - - -	1,071
	5,201

At a Rateable Value of—	
£4 and under £5 is - -	971
£5 and under £6 - - -	710
£6 - - - - -	175
Above £6 and under £7 - -	148
£7 and under £8 - - -	348
£8 and under £9 - - -	77
£9 and under £10 - - -	156
£10 and over - - - -	934

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

169. WARWICK.

Population in 1831 - 9,109	Population in 1861	-	10,570	Increase	- 1,461
	Population in 1866 (computed)	-	10,374	Increase	- 1,265

Inhabited Houses in 1861 - - 2,272

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6	Increase.	Decrease.
£10 Occupiers - -	—	641	641	—
Scot and Lot Voters - -	1,340	125	—	1,215
Total - -	1,340	766	641	1,215
			Net Decrease. 574	

Double entries on Register of 1865-6:—

As £10 Occupiers - - - -	2	76	Number who voted at the last General Election.
As £10 Occupiers and Scot and Lot Voters	74		
Actual Number of Electors - - -		690	607

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - -	122
As Scot and Lot Voters - - - -	42
Total - - - -	164

Number of Burgesses - - - - - - - - - 1,416

Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him 719

Number who are on the Parliamentary Register - - - - - - 603

The Small Tenements Act has been adopted. The number of Burgesses before its adoption was 1,111.

The Gross Estimated Rental—	£
In 1856 was - - - -	47,290
The present Gross Estimated Rental is - - - - -	48,411
Increase - - -	1,121

The Rateable Value—	£	
In 1856 was - -	36,537	Increase since 1856 £4,886
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	37,147	since 1862 £4,276
The present Rateable Value is - - -	41,423	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	49,785
The Gross Estimated Rental of the same description of property according to the Valuation List is	46,022

The Number of Male Occupiers:—

At a Gross Estimated Rental of—*	
Under £6 is - - - -	642
£6 and under £7 - - -	253
£7 and under £8 - - - -	163
£8 and under £9 - - -	67
£9 and under £10 - - -	70
£10 and over - - - -	740
	1,935

At a Rateable Value of—	
£4 and under £5 is - - -	213
£5 and under £6 - - -	305
£6 - - - - -	21
Above £6 and under £7 - -	61
£7 and under £8 - - -	73
£8 and under £9 - - -	119
£9 and under £10 - - -	68
£10 and over - - -	515

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £6, and 20 per cent. in the case of Houses above £6.

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* It is stated that there are very few houses where the owner pays the rates if the rental exceeds £6.

170. WELLS.

Population in 1831 - 4,603	Population in 1861 -	4,648	Increase - 45
	Population in 1866 (computed) -	4,605	Increase - 2

Inhabited Houses in 1861 - - 863

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	195	230	35	—
Freemen - - -	163	66	—	97
Total - - -	358	296	35	97

Net Decrease.
62

Double entries on Register of 1865–6:—

As £10 Occupiers -	3	22
As £10 Occupiers and Freemen	19	
Actual Number of Electors. - -		274

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - -	4
As Freemen - - - - -	39
Total - - -	43
Deduct double entry - -	1
Net Number - - -	42

Number of Burgesses - - - - - - - - - -	424
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	None.
Number of Burgesses on the Parliamentary Register - - - - - -	213

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - - -	13,599
The present Gross Estimated Rental is - - - - -	14,964
Increase - -	1,365

The Rateable Value—	£	
In 1856 was - - -	11,619	Increase since 1856 £1,317
In 1862 immediately before the date of the Union Assessment Committee Act it was - - -	11,651	since 1862 £1,285
The present Rateable Value is - - - -	12,936	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	15,194*
The Gross Estimated Rental of the same description of Property according to the Valuation List is	14,612*

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	358
£6 and under £7 - - - - -	59
£7 and under £8 - - - -	20
£8 and under £9 - - - - -	22
£9 and under £10 - - - -	12
£10 and over - - - -	306
	777

At a Rateable Value of—	
£4 and under £5 is - - - -	94
£5 and under £6 - - - -	59
£6 - - - - - - -	18
Above £6 and under £7 - - - -	6
£7 and under £8 - - - - -	23
£8 and under £9 - - - -	48
£9 and under £10 - - - -	18
£10 and over - - - - -	236

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The difference between the two assessments chiefly occurs in the case of old houses on the outskirts of the borough.

171. WENLOCK.

Population in 1831	17,435	Population in 1861	21,590	Increase	4,155
		Population in 1866 (computed)	22,109	Increase	4,674

Inhabited Houses in 1861 - - 4,369

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	—	851	851	—
Freemen, Burgesses	202	142	—	60
Scot and Lot Voters	489	—	—	489
Total	691	993	851	549
			Net Increase. 302	

Double entries on Register of 1865–6:—

As £10 Occupiers	9	32
As £10 Occupiers and Freemen	23	
Actual Number of Electors		961

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	184
As Freemen	84
Total	268
Double entries	7
Net Number	261*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in 15 of the 20 Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was	79,821
The present Gross Estimated Rental is	85,997
Increase	6,176

The Rateable Value—	£	
In 1856 was	71,391	Increase since 1856 £8,789
In 1862 immediately before the date of the Union Assessment Committee Act it was	73,281	since 1862 £6,899
The present Rateable Value is	80,180	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	84,236
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is	76,336

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	2,090
£6 and under £7	292
£7 and under £8	137
£8 and under £9	82
£9 and under £10	55
£10 and over	930
	3,586

At a Rateable Value of—	
£4 and under £5 is	716
£5 and under £6	218
£6	4
Above £6 and under £7	129
£7 and under £8	106
£8 and under £9	70
£9 and under £10	75
£10 and over	776

In 18 Parishes the Gross Estimated Rental it is stated represents the full rack rent, and in one Parish the rent at which the property might be expected to let from year to year in accordance with the Union Assessment Committee Act.

A deduction of 12½ per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parishes of Barrow, Benthall, Broseley, Ditton Priors (part of), Deuxhill, Hughley, Linley, Madeley, Posenhall, Little Wenlock, Much Wenlock, and Willey; 10 per cent. in the Parishes of Eaton and Shipton; 20 per cent. in the Parishes of Badger and Beckbury, in Munslow and Stoke Milborough 20 per cent. for houses at and over £8, and 30 per cent. for houses under £8.

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* It is stated that a great portion of the inhabitants of the borough are employed in the ironworks and china manufactories, and are of a superior class of artizans.

172. WESTBURY.

Population in 1831 -	7,324	Population in 1861 -	6,495	Decrease -	829
		Population in 1866 (computed) -	6,243	Decrease -	1,081

Inhabited Houses in 1861 - - 1,526*

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers -	185	300	115
Actual Number of Electors - - -		300	No contest at the last General Election.

(No double entries on Register.)

Number of Working Classes on the present Parliamentary Register - - 142*

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - -	29,576
The present Gross Estimated Rental is - - - -	31,789
Increase - -	2,213

The Rateable Value—	£	
In 1856 was - -	22,964	Increase since 1856 £4,938
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	23,523	since 1862 £ 4,379
The present Rateable Value is - - -	27,902	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	32,903
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	30,602

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	1,031
£6 and under £7 - - -	65
£7 and under £8 - - -	49
£8 and under £9 - - -	19
£9 and under £10 - - -	54
£10 and over - - -	326
	1,544

At a Rateable Value of—	
£4 and under £5 is - - -	152
£5 and under £6 - - -	50
£6 - - - - - - -	18
Above £6 and under £7 - -	17
£7 and under £8 - - -	31
£8 and under £9 - - -	50
£9 and under £10 - - -	26
£10 and over - - - -	320

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 15 to 25 per cent., according to the condition of the Houses, is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* In the borough of Westbury there are several cloth manufactories, and there are a great number of persons occupying small quantities of land, some as little as one acre, others from two to three acres and upwards, who obtain their living principally by working on the land and from their own manual labour, although in some instances they have little shops principally kept by their wives.

173. WESTMINSTER.

Population in 1831 -	206,547	Population in 1861 -	254,623	Increase -	48,076
		Population in 1866 (computed) -	261,389	Increase -	54,842
Inhabited Houses in 1861 - -			26,286		

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers -	Qualifications not distinguished.	12,386	
Scot and Lot Voters -		431	
Total - -	11,576	12,817	1,241

Double entries on Register of 1865–6 :—

As £10 Occupiers and Scot and Lot Voters -	271	Number of Votes recorded at the last General Election.
Actual Number of Electors - -	12,546	12,883

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - -	1,514
As Scot and Lot Voters - - - -	2
Total - - - -	1,516
Double entries -	23
Net Number - - -	1,493

There are several Local Acts in force. The 42 Geo. 3. c. 72. s. 25. in St. Anne, Soho, authorizing the rating of landlords whose houses are let in separate apartments or furnished lodgings. The 10 Geo. 3. in St. Clement Danes, the 2 Geo. 3. c. 58. in St. James, Westminster, the 25 Geo. 2. c. 23. in St. John the Evangelist and St. Margaret, and the 10 Geo. 3. c. 64. in St. Martin-in-the-Fields, with a similar provision. The 7 Geo. 4. c. 121. in St. George's, Hanover Square, providing that the landlord shall be rated for tenements let for less than £5 a year, and that the landlord, or one or more of the occupiers, shall be liable for houses let ready furnished or in separate apartments; and the 51 Geo. 3. c. 64. in St. Mary-le-Strand with a rating limit of "under £20 yearly rent or value," except where houses are let for a shorter period than quarterly, or let in lodgings or separate apartments.

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was - - - -	2,197,838	In 1856 was - -	1,907,836	Increase since 1856
The present Gross Estimated Rental is	2,558,716	The present Rateable Value is - - -	2,245,645	£337,809
Increase - - -	360,878			

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	2,858,306
The Gross Estimated Rental of the same description of Property according to the Valuation List is	2,501,352

The Number of Male Occupiers :—

—	At a Gross Estimated Rental of								At a Rateable Value of							
	Under £4.	£4 and under £5.	£5 and under £6.	£6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10.	£10 and over.	£4 and under £5.	£5 and under £6.	£6.	Above £6 and under £7.	£7 and under £8.	£8 and under £9.	£9 and under £10,	£10 and over.
Strand Union -	—	1	1	1	—	1	—	2,708	1	2	1	—	2	5	4	2,693
St. James - -	—	—	—	—	—	—	—	2,560	—	—	—	—	—	—	—	2,560
St. Margaret and St. John - -	4	48	180	168	148	213	64	5,047	48	180	168	—	148	213	64	5,047
St. George, Hanover Square - -	—	—	—	—	292	—	74	7,103	—	—	267	—	—	76	—	7,114
St. Martin-in-the-Fields - -	—	—	—	—	—	—	—	1,698	—	—	—	—	—	—	—	1,698
Total - -	4	49	181	169	440	214	138	19,116	49	182	436	—	150	294	68	19,112

Strand Union comprises the following parishes in the City :—St. Anne, Soho, St. Clement Danes, St. John Baptist Savoy, St. Mary-le-Strand, and St. Paul, Covent Garden. The Gross Estimated Rental is stated to represent the full rack rent. A deduction of about 25 per cent. is made in arriving at the Rateable Value.

Mr. Kilner, the Clerk to the Guardians, states that there is in his district a large number of houses let out in distinct tenements by Landlords who do not themselves reside on the premises. The Landlord in these cases insure, repair, and pay all rates and taxes on the premises. The tenants' names never appear on the Rate Books. The number of houses let out in distinct tenements is as follows :—At £10 and over, Rateable Value, 687; at £9 and under £10, 24; at £8 and under £9, 10; at £7 and under £8, 1; at £6, 3; at £4 and under £6, 5. These houses are not included in the Return of Male Occupiers.

On an inquiry as to the number of tenants and the rents paid by them in 12 houses in the parish of St. Anne, Westminster, held by one Landlord, it was ascertained that there were (including the apartments from the kitchen to the attics) 1 tenant at 1*s.* 6*d.* per week, 4 at 2*s.*, 1 at 2*s.* 3*d.*, 14 at 2*s.* 6*d.*, 1 at 2*s.* 9*d.*, 5 at 3*s.*, 2 at 3*s.* 3*d.*, 12 at 3*s.* 6*d.*, 11 at 4*s.*, 1 at 4*s.* 3*d.*, 7 at 4*s.* 6*d.*, 10 at 5*s.*, and 8 at 5*s.* 6*d.*; and also for shops in the same houses, 1 tenant at 10*s.* per week, 4 at 10*s.* 6*d.*, 1 at 11*s.*, and 2 at 20*s.* There were therefore 85 distinct lettings, averaging 7 for each house.

St. James, Westminster, Parish.—There are no houses under £10 value in the parish.

There are about 550 houses let out in distinct tenements. The number of separate occupations can only be ascertained by a house-to-house visitation. Since the Reform Act passed in 1832 there have not been more than a dozen instances in which the Occupiers of houses or parts of houses let out in separate tenements have claimed to be rated, and at the present time there is only one such case on the Register of Voters.

St. Margaret and St. John, Westminster, Parishes.—The Gross Estimated Rental is stated to represent the full rack rent, and that to arrive at the full rack rent the Property Tax Assessment is resorted to, and generally adopted. A deduction of 10 per cent. is generally made in arriving at the Rateable Value.

In explanation of the slight variation between the Number of Occupiers under the several heads of Gross Estimated Rental and Rateable Value it is stated that the figures come out nearly the same in both forms, the difference between the Gross Estimated Rentals and the Rateable Value being for sums under £10 less than £1.

The number of houses of £10 Gross Estimated Rental compounded for is 1,418.

There are between 600 and 700 houses which are believed to be let out in distinct tenements. The number of separate occupations is presumed to be above 1,500, and the value of each is estimated to be at 4*s.* a week and upwards. It is impossible to obtain accurate information on this subject without a house-to-house visitation.

Neither the Occupiers of houses in respect of which the Owners are assessed, nor the Occupiers of rooms in houses let out in distinct tenements, appear on the Register.

St. George, Hanover Square, Parish.—The excess of Male Occupiers at £10 Rateable Value as compared with the number of Male Occupiers at £10 Gross Estimated Rental is explained by the fact that the former Return was made in October 1865, and the latter in December, and that between the two periods in several cases Males became Occupiers of houses previously held by Females, and some empty houses became occupied. The Vestry Clerk is not aware of any houses being let in distinct tenements. A house-to-house visitation would be necessary to obtain precise information.

St. Martin-in-the-Fields Parish.—The Gross Estimated Rental represents the full rack rent. About 20 per cent. is deducted from the Gross Estimated Rental in arriving at the Rateable Value.

The number of Owners rated instead of Occupiers are 234. The Occupiers of compounded tenements do not appear on the Register.

There are 291 houses let out in distinct tenements. The number of separate occupations could only be accurately ascertained by a house-to-house visitation. The Occupiers of houses let out in distinct tenements are not placed on the Register. There is on record one instance of the Occupier of a tenement being on the list of Voters, but he was struck off by the revising Barrister.

174. WEYMOUTH AND MELCOMBE REGIS.

Population in 1831 - 8,439	Population in 1861 -	11,383	Increase -	2,944
	Population in 1866 (computed) -	12,488	Increase -	4,049

Inhabited Houses in 1861 - - 1,864

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.
£10 Occupiers - -	Qualifications not distinguished.	931	
Freemen - - -		4	
Freeholders - - -		3	
Total - -	475	938	463

Double entries on Register of 1865-6:—

As £10 Occupiers - -	25	32	Number who voted at the last General Election.
As £10 Occupiers and Freemen or Freeholders - -	7		
Actual Number of Electors - -		906	558

Number of Working Classes on the present Parliamentary Register - - 356*

Number of Burgesses - - - - - - - - - - 1,157

Number of Burgesses whose Rates are assessed on or compounded for by the Owner - 323

Number of Burgesses on the Parliamentary Register - - - - - 780

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was - - -	35,826
The present Gross Estimated Rental is - - - - -	46,718
Increase - - -	10,892

The Rateable Value—	£	
In 1856 was - -	26,690	Increase since 1856 £10,661
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	31,743	since 1862 £5,608
The present Rateable Value is - - -	37,351	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	52,099†
The Gross Estimated Rental of the same description of Property according to the Valuation List is	45,070†

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	288
£6 and under £7 - - -	101
£7 and under £8 - - -	37
£8 and under £9 - - -	46
£9 and under £10 - - -	13
£10 and over - - - -	1,066
	1,551

At a Rateable Value of—	
£4 and under £5 is - - -	259
£5 and under £6 - - -	30
£6 - - - - - -	5
Above £6 and under £7 -	46
£7 and under £8 - - -	15
£8 and under £9 - - -	269
£9 and under £10 - - -	168
£10 and over - - -	631

The Gross Estimated Rental it is stated is based upon the Income Tax Return, Schedule A., with a deduction of 5 per cent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With respect to the large number of Working Classes on the Register the explanation given is that it is to be attributed to the fact of the Borough being a populous seaport, in consequence of which rents are comparatively high, and but a very small number of the Working Classes occupy houses at a less rent than £10 a year. Many let lodgings.

† The Clerk to the Guardians ascribes the difference between these amounts to the fact that there are several assessments to the Income Tax in respect of incorporeal hereditaments not assessed to the Poor Rate, such as Harbour and Coal Dues, Bridge and Pier Dues, &c. The Surveyor of Taxes, however, states that he is satisfied that the Poor Rate is about 20 per cent. below the actual rental assessed to the Income Tax.

175. WHITBY.

Population in 1831 - 10,399	Population in 1861 -	12,051	Increase -	1,652
	Population in 1866 (computed) -	12,620	Increase -	2,221

Inhabited Houses in 1861 - - 2,464

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - -	422	761	339

		Number who voted at the last General Election.
Double entries on Register of 1865-6 - - - - -	58	
Actual Number of Electors - - -	703	587

Number of Working Classes on the present Parliamentary Register. - - 30*

The Gross Estimated Rental—

	£
In 1856 was - - -	31,053
The present Gross Estimated Rental is - - - -	49,409
Increase - - -	18,356

The Rateable Value—

	£	
In 1856 was - - -	27,883	Increase since 1856 £12,074
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	33,028	since 1862 £6,929
The present Rateable Value is - - -	39,957	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	47,447
The Gross Estimated Rental of the same description of Property according to the Valuation List is	47,456

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	1,247
£6 and under £7 - - -	129
£7 and under £8 - - -	67
£8 and under £9 - - - -	50
£9 and under £10 - - -	35
£10 and over - - - -	852
	2,380

At a Rateable Value of—	
£4 and under £5 is - - -	178
£5 and under £6 - - -	87
£6 - - - -	27
Above £6 and under £7 - -	65
£7 and under £8 - - -	45
£8 and under £9 - - -	151
£9 and under £10 - - -	41
£10 and over - - -	694

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6, and of 25 per cent. in the case of Houses under £6.

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* With reference to the number of the Working Classes on the Register it is stated that the ratings above £6 principally consist of public houses, hotels, large houses, shops, and warehouses, docks, &c.

176. WHITEHAVEN.

Population in 1831 -	15,716	Population in 1861 -	18,842	Increase -	3,126
		Population in 1866 (computed) -	18,805	Increase -	3,089

Inhabited Houses in 1861 - - 3,751

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.
£10 Occupiers - - -	458	648	190
Actual Number of Electors (No Double entries.) - -		648	No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - 138

No Municipal Corporation.

The Gross Estimated Rental—	£
In 1856 was - - - - -	45,602
The present Gross Estimated Rental is - - - - - -	54,003
Increase - - -	8,401

The Rateable Value—	£	
In 1856 was - -	39,072	Increase since 1856 £5,848
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	43,180	
The present Rateable Value is - - - -	44,920	since 1862 £1,740

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	47,244
The Gross Estimated Rental of the same description of Property according to the Valuation List is	47,439

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	2,597
£6 and under £7 - - - -	343
£7 and under £8 - - -	132
£8 and under £9 - - -	112
£9 and under £10 - - -	81
£10 and over - - - -	887
	4,152

At a Rateable Value of—*	
£4 and under £5 is - - -	734
£5 and under £6 - - - -	213
£6 - - - - - -	15
Above £6 and under £7 - - -	128
£7 and under £8 - - - -	91
£8 and under £9 - - - -	133
£9 and under £10 - - -	48
£10 and over - - - -	608

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £7 10*s*., and of 15 per cent. in the case of Houses above £7 10*s*.

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* In Whitehaven parish there are 786 houses at £4 and under £6, and 5 at £6, for which the Owners are assessed. In these cases the number of tenements and not the number of Male Occupiers is given.

177. WIGAN.

Population in 1831 -	20,774	Population in 1861 -	37,658	Increase -	16,884
		Population in 1866 (computed) -	40,889	Increase -	20,115

Inhabited Houses in 1861 - - 6,696

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	423	862	439	—
Burgesses (ancient right) -	60	3	—	57
Total - -	483	865	439	57
			Net Increase. 382	

Double entries on Register of 1865–6:—

As £10 Occupiers and Burgesses - -	2
Actual Number of Electors - -	863

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - - 205

Number of Burgesses - - - - - - - - - -	2,931
Number of Burgesses whose Rates are assessed on the Owner, or compounded for by him	2,069
Number who are on the Parliamentary Register - - - - - -	862

The Small Tenements Act has been adopted. The number of Burgesses before the adoption of the Act was 1,227.

The Gross Estimated Rental—	£
In 1856 was - - -	77,762
The present Gross Estimated Rental is	95,555
Increase - - -	17,793

The Rateable Value—	£	
In 1856 was - -	65,882	Increase since 1856 £12,166
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	72,650	since 1862 £5,398
The present Rateable Value is - - -	78,048	

	£
The Gross Annual Value of all Mesuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	85,370
The Gross Estimated Rental of the same description of Property according to the Valuation List is	80,864

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	3,467
£6 and under £7 - - - - -	1,035
£7 and under £8 - - - -	735
£8 and under £9 - - - -	39
£9 and under £10 - - -	34
£10 and over - - - - -	1,302*
	6,612

At a Rateable Value of—	
£4 and under £5 is - - -	1,291
At £5 and under £6 -	867
At £6 - - - -	588
Above £6 and under £7 - -	29
At £7 and under £8 - -	32
At £8 and under £9 - - -	175
At £9 and under £10 - - -	38
At £10 and over - - -	950

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of about one sixth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* With reference to the large excess of £10 Occupiers Gross Estimated Rental as compared with the number of Electors on the Register at £10 Occupiers it is stated that the difference is occasioned by double qualifications, insufficient length of residence, non-payment of rates, &c.

178. WILTON.

Population in 1831	7,753	Population in 1861	8,657	Increase	904
		Population in 1866 (computed)	8,682	Increase	929

Inhabited Houses in 1861 - - 1,814

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase	Decrease.
£10 Occupiers	214	273	59	—
Freemen	17	—	—	17
Total	231	273	59	17

Net Increase.
42

Double entries on Register of 1865–6 :—

As £10 Occupiers	8
Actual Number of Electors	265

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 35

The Small Tenements Act has been adopted by 13 Parishes (including that of Wilton). This not in force in the remaining 6.

The Gross Estimated Rental—

	£
In 1856 was	58,248
The present Gross Estimated Rental is	61,686
Increase	3,438

The Rateable Value—

	£	
In 1856 was	46,263	Increase since 1856 £8,268
In 1862 immediately before the date of the Union Assessment Committee Act it was	50,801	since 1862 £3,730
The present Rateable Value is	54,531	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	60,520
The Gross Estimated Rental of the same description of Property according to the Valuation List and last Poor Rate is	60,201

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	1,119
£6 and under £7	50
£7 and under £8	44
£8 and under £9	38
£9 and under £10	16
£10 and over	349
	1,616

At a Rateable Value of—	
£4 and under £5 is	98
£5 and under £6	29
£6	33
Above £6 and under £7	34
£7 and under £8	26
£8 and under £9	28
£9 and under £10	17
£10 and over	260

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in 6 parishes ; from 10 to 30 per cent. in 8 parishes ; 20 per cent. in 2 parishes ; from 15 to 20 per cent. in 2 parishes ; and from 15 to 30 per cent. in 1 parish.

179. WINCHESTER.

Population in 1831	9,292	Population in 1861	14,776	Increase	5,484
		Population in 1866 (computed)	15,343	Increase	6,051

Inhabited Houses in 1861 - - - 2,392

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	465	988	523	—
Freemen	66	3	—	63
Total	531	991	523	63
			Net Increase. 460	

Double entries on Register of 1865–6 :—

As £10 Occupiers	25	28	Number who voted at the last General Election.
As £10 Occupiers and Freemen	3		
Actual Number of Electors		963	779

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - - 228

Number of Burgesses	1,233
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	290
Number of Burgesses on the Parliamentary Register	963

The Small Tenements Act is in force in 11 of the 21 Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was	50,203
The present Gross Estimated Rental is	63,401
Increase	13,198

The Rateable Value—	£	
In 1856 was	42,042	Increase since 1856 £9,025
In 1862 immediately before the date of the Union Assessment Committee Act it was	47,221	since 1862 £3,846
The present Rateable Value is	51,067	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	56,974
The Gross Estimated Rental of the same description of Property according to the Valuation List is	59,376

The Number of Male Occupiers :—

At a Gross Estimated Rental—	
Under £6 is	168
£6 and under £7	191
£7 and under £8	251
£8 and under £9	112
£9 and under £10	65
£10 and over	1,058
	1,845

At a Rateable Value of—*	
£4 and under £5 is	174
£5 and under £6	301
£6	53
Above £6 and under £7	129
£7 and under £8	70
£8 and under £9	180
£9 and under £10	90
£10 and over	828

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6 and under £10, and of 25 per cent. in the case of Houses at £6 and under.

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* The returns for the extra-parochial places, Bishop Morley's College, Cathedral Yard, Close of Winchester, St. Cross Hospital, Winchester College, St. Mary's College, and Wolvesley and Wharf, are based on the assessments to the borough rate.

180. WINDSOR, NEW.

Population in 1831 -	7,071	Population in 1861 -	9,520	Increase -	2,449
		Population in 1866 (computed) -	9,482	Increase -	2,411

Inhabited Houses in 1861 - - 1,577

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - -	—	657	
Scot and Lot Voters - -	507	—	
Total - - -	507	657	150

		Number who voted at the last General Election.
Double entries on Register of 1865–6 :—		
As £10 Occupiers - - - - -	6	
Actual Number of Electors - -	651	603

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 215

Number of Burgesses - - - - - - - - -	731
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	223
Number of Burgesses on the Parliamentary Register - - - - -	524

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was - - -	35,651
The present Gross Estimated Rental is - - - -	44,708
Increase - - -	9,057

The Rateable Value—	£	
In 1856 was - -	29,108	Increase since 1856 £4,248
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	31,747	
The present Rateable Value is - - - - -	33,356	since 1862 £1,609

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - -	47,392
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	42,763*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	94
£6 and under £7 - - - -	48
£7 and under £8 - - -	75
£8 and under £9 - - -	65
£9 and under £10 - - -	50
£10 and over - - -	951
	1,283

At a Rateable Value of—	
£4 and under £5 is - - -	76
£5 and under £6 - -	90
£6 - - - - -	44
Above £6 and under £7 - -	73
£7 and under £8 - - -	179
£8 and under £9 - - -	20
£9 and under £10 - - -	65
£10 and over - -	673

The Gross Estimated Rental is stated to represent the full rack rent.

In the Parish of New Windsor a deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, and in the Parish of Clewer (a part of which is within the Borough) a deduction of one third is made.†

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* The Valuation Lists in this Union are not yet complete.

† It is stated that the rates upon all houses at and under £10 are paid by the landlords, and an increase of from one sixth to one fourth is added to the rent to cover such outlay.

181. WOLVERHAMPTON.

Population in 1831	67,514	Population in 1861	147,670	Increase	80,156
		Population in 1866 (computed)	163,985	Increase	96,471

Inhabited Houses in 1861 - - 28,432

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers	1,700	4,891	3,191

		Number who voted at the last General Election.
Double entries on Register of 1865–6 :—		
As £10 Occupiers	61	
Actual Number of Electors	4,830	1,618

Number of Working Classes on the present Parliamentary Register - - 1,244

The Parliamentary and Municipal Boundaries are not conterminous.

A Local Act, 10 Vict. c. 30., is in force in the Parishes of Wolverhampton, Bilston, Willenhall, and Wednesfield, the limit for rating the owner being £6 10*s.* Rateable Value (except as to tenements formed after the passing of the Act into one or more houses, and let in lodgings or separate apartments). The right of voting on all parochial matters is secured to the occupiers of tenements for which the owner is assessed.

The Small Tenements Act is in force in the remaining Parish.

The Gross Estimated Rental—	£
In 1856 was	360,790
The present Gross Estimated Rental is	458,618
Increase	97,828

The Rateable Value—	£	
In 1856 was	298,409	Increase since 1856 £70,332
In 1862 immediately before the date of the Union Assessment Committee Act it was	322,368	since 1862 £46,373
The present Rateable Value is	368,741	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	378,770
The Gross Estimated Rental of the same description of Property according to the Valuation List is	351,064

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	10,951	£4 and under £5 is	5,251
£6 and under £7	3,824	£5 and under £6	5,708
£7 and under £8	4,639	£6	381
£8 and under £9	1,444	Above £6 and under £7	1,394
£9 and under £10	643	£7 and under £8	1,289
£10 and over	5,645	£8 and under £9	1,265
		£9 and under £10	664
	27,146	£10 and over	4,786

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

As a rule, all tenements at and under 3*s.* 6*d.* per week, the landlord paying the rates, are rated to the owners, and also some few at 3*s.* 9*d.* and 4*s.* a week where the property is badly tenanted or in a bad situation.

182. WOODSTOCK.

Population in 1831	7,115	Population in 1861	7,827	Increase	712
		Population in 1866 (computed)	7,750	Increase	635

Inhabited Houses in 1861 - - 1,663

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	241	280	39	—
Freemen	76	16	—	60
Total	317	296	39	60
			Net Decrease. 21	

Double entries on Register of 1865–6 :—			
As £10 Occupiers	3	10	Number who voted at the last General Election.
As £10 Occupiies and Freemen	7		
Actual Number of Electors		286	262

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	22
As Freemen	4
Total	26

The Small Tenements Act has been adopted in 8 of the 14 Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was	33,802
The present Gross Estimated Rental is	46,573
Increase	12,771

The Rateable Value—	£	
In 1856 was	29,281	Increase since 1856 £10,087
In 1862 immediately before the date of the Union Assessment Committee Act it was	31,627	since 1862 £7,741
The present Rateable Value is	39,368	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	44,402
The Gross Estimated Rental of the same description of Property according to the Valuation List is	42,623

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	859
£6 and under £7	69
£7 and under £8	22
£8 and under £9	29
£9 and under £10	9
£10 and over	300
	1,288

At a Rateable Value of—	
£4 and under £5 is	209
£5 and under £6	27
£6	19
Above £6 and under £7	15
£7 and under £8	21
£8 and under £9	12
£9 and under £10	35
£10 and over	243

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of one fourth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

183. WORCESTER.

Population in 1831 - 25,659	Population in 1861	- 31,227	Increase	-	5,568
	Population in 1866 (computed)	- 33,259	Increase	-	7,600

Inhabited Houses in 1861 - - 6,330

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	—	1,944	1,944	—
Freemen - - -	1,512	732	—	780
Scot and Lot Voters - -	854	—	—	854
Total - - -	2,366	2,676	1,944	1,634
			Net Increase. 310	

Double entries on Register of 1865–6 :—

As £10 Occupiers - -	106	367	Number who voted at the last General Election.
As £10 Occupiers and Freemen	261		
Actual Number of Electors - -		2,309	

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - -	587
As Freemen - - - -	346
Total - - -	933
Deduct Double entries - -	72
Net Number - - -	861*

Number of Burgesses - - - - - - - -	3,052
Number of Burgesses whose Rates are assessed on or compounded for by the Owner -	367
Number of Burgesses on the Parliamentary Register - - - -	1,546

The Small Tenements Act is in force in all the Parishes except the College Precincts.

The Gross Estimated Rental—

	£
In 1856 was - - -	90,450
The present Gross Estimated Rental is - - - - -	126,898
Increase - - -	36,448

The Rateable Value—

	£	
In 1856 was - -	76,412	Increase since 1856 £29,521
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	93,918	since 1862 £12,015
The present Rateable Value is - - -	105,933	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	121,657
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is - - - - - - - - -	121,259

The Number of Male Occupiers :—

At a Gross Estimated Rental of—

Under £6 is - - -	1,045
£6 and under £7 - - -	636
£7 and under £8 - - -	660
£8 and under £9 - - -	443
£9 and under £10 - - -	318
£10 and over - - -	2,786
	5,888

At a Rateable Value of—†

£4 and under £5 is - - -	744
£5 and under £6 - - -	776
£6 - - - -	367
Above £6 and under £7 - -	100
£7 and under £8 - - -	330
£8 and under £9 - - -	395
£9 and under £10 - - -	176
£10 and over - - -	2,132

The Gross Estimated Rental it is stated represents the full rack rent in almost all cases, except where, by arrangement between themselves, the landlord allows and repays to the tenant the amount of rates not compounded for, and then a deduction of 15 per cent. is made.

In the several Parishes, with the exception of Claines, a deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10. In the Parish of Claines a deduction varying from 15 to 20 per cent. is made.

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* With reference to the number of the Working Classes on the Register it is stated that the manufactures of Worcester are of such a nature as to employ a large number of the persons within that class ; viz., china painters, glovers, foundrymen, engine and boiler makers, &c. &c.

† In the parish of Claines there are 60 tenements at £4 and under £6, 6 at £6, 3 above £6 and under £7, and 22 at £7 and under £8, in respect of which the Owners are assessed. The number of tenements and not of Male Occupiers is given in these cases.

184. WYCOMBE.

Population in 1831 -	6,299	Population in 1861 -	8,373	Increase -	2,074
		Population in 1866 (computed)	9,043	Increase -	2,744

Inhabited Houses in 1861 - - 1703

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers - - - -	270	551	281	—
Burgesses - - - - -	28	2	—	26
Total - - - -	298	553	281	26

Net Increase. 255

Double entries on Register of 1865-6:—

As £10 Occupier - - - -	1	2
As £10 Occupier and Burgess - -	1	
Actual Number of Electors - - - -		551

No contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - - 116*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted.

The Gross Estimated Rental—	£
In 1856 was - - - - -	21,882
The present Gross Estimated Rental is - - - - - -	30,473
Increase - - - -	8,591

The Rateable Value—	£	
In 1856 was - -	18,960	Increase since 1856 £5,749
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	20,581	since 1862 £4,128
The present Rateable Value is - - - -	24,709	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	31,534
The Gross Estimated Rental of the same description of Property according to the Valuation List is	29,548

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	669
£6 and under £7 - - - - -	152
£7 and under £8 - - - - -	114
£8 and under £9 - - - - -	88
£9 and under £10 - - - -	29
£10 and over - - - - -	538†
	1,590

At a Rateable Value of—	
£4 and under £5 is - - - -	253
£5 and under £6 - - - - -	124
£6 - - - - - - -	33
Above £6 and under £7 - - - -	70
£7 and under £8 - - - - -	34
£8 and under £9 - - - - -	77
£9 and under £10 - - - - -	56
£10 and over - - - - -	368

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of from 15 to 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10; viz., 15 per cent. for new cottages, 20 for those in fair repair, and 25 for thatched or dilapidated cottages.

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* The large number of the Working Classes on the Register is attributed to the existence of large chair manufactories in the borough, and the number of houses which have been built within the last few years for the accommodation of the persons employed.

† With reference to the excess of Electors on the Register as £10 Occupiers over the Male Occupiers at a Gross Estimated Rental of £10, it is stated that the returns have been prepared from the Valuation Lists of March 1864. The Parish of Wycombe has much increased since that date. A Valuation List including the new property is being prepared.

185. GREAT YARMOUTH

Population in 1831	24,535	Population in 1861	34,810	ncrease	10,275
		Population in 1866 (computed)	36,959	Increase	12,424

Inhabited Houses in 1861 - - 7,792

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Decrease.
£10 Occupiers	643	1,650	
Freemen	1,040	—	
Total	1,683	1,650	33

Double entries on Register of 1865–6 :—		Number who voted at the last General Election.
As £10 Occupiers	5	
Actual Number of Electors	1,645	1,432

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	327
Deduct Double entries	3
Net Number	324*

Number of Burgesses	2,408
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	388
Number of Burgesses on the Parliamentary Register	1,357

The Small Tenements Act was adopted in 1855, and rescinded in 1856. It has recently been adopted again, and the Town Clerk states that if all the compounded Occupiers claim to be put on the Burgess Lists next year the number of Burgesses of that class will exceed 2,000 next year.

The Gross Estimated Rental—	£
In 1856 was	88,701
The present Gross Estimated Rental is	109,191
Increase	20,490

The Rateable Value—	£	
In 1856 was	61,833	Increase since 1856 £9,936
The present Rateable Value is	71,769	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	108,562
The Gross Estimated Rental of the same description of Property according to the Valuation List is	106,303

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	2,289	£4 and under £5 is	122
£6 and under £7	1,294	£5 and under £6	60
£7 and under £8	627	£6	20
£8 and under £9	277	Above £6 and under £7	349
£9 and under £10	93	£7 and under £8	86
£10 and over	2,080	£8 and under £9	372
		£9 and under £10	172
	6,660	£10 and over	1,397

The Gross Estimated Rental is stated to represent the full rack rent.

In the Parish of Great Yarmouth a deduction of one fifth is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and above £8, and Houses under £8 are compounded for at three tenths of the rentals. In the Parish of Gorleston a deduction of one third is made.

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* With reference to the number of the Working Class on the Register it is stated that a great many persons who come within that description occupy houses at and above £10 rental, whose wives let their houses or apartments to visitors in the summer months, living in some portion of the house, or managing to keep a room or closet to themselves, so as to keep on the Register and possess the franchise, which in Yarmouth is considered of some importance.

186. YORK.

Population in 1831	28,244	Population in 1861	45,385	Increase	17,141
		Population in 1866 (computed)	48,128	Increase	19,884

Inhabited Houses in 1861 - - 9,162

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	531	2,153	1,622
Freemen	2,342	2,571	229
Total	2,873	4,724	1,851

Double entries on Register of 1865–6:—

As £10 Occupiers	101	447	
As £10 Occupiers and Freemen	346		Number who voted at the last General Election.
Actual Number of Electors		4,277	3,828

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	112
As Freemen	1,381
Total	1,493
Deduct Double entries	23
Net Number	1,470

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has not been adopted.

The Gross Estimated Rental—	£
In 1856 was	136,547
The present Gross Estimated Rental is	172,847
Increase	36,300

The Rateable Value—	£	
In 1856 was	112,117	Increase since 1856 £36,600
In 1862 immediately before the date of the Union Assessment Committee Act it was	142,930	since 1862 £5,787
The present Rateable Value is	148,717	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	161,958
The Gross Estimated Rental of the same description of Property according to the Valuation List is	162,756

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	2,727
£6 and under £7	852
£7 and under £8	631
£8 and under £9	387
£9 and under £10	287
£10 and over	3,579*
	8,463

At a Rateable Value of—	
£4 and under £5 is	914
£5 and under £6	852
£6	399
Above £6 and under £7	495
£7 and under £8	353
£8 and under £9	405
£9 and under £10	175
£10 and over	3,107

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10.

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* The reason why the number of Male Occupiers at £10 and over is so much in excess of the number of £10 Voters appears to be that a considerable number of Freemen who are £10 Occupiers appear on the Register as Freemen only.

187. WALES.—BEAUMARIS.

Population in 1831 -	10,687	Population in 1861 -	13,275	Increase -	2,588
		Population in 1866 (computed) -	13,544	Increase -	2,857

Inhabited Houses in 1861 - - - 2,942

Number of Electors on Parliamentary Register:—

	1832-3.	1865–5.	Increase.
£10 Occupiers - - -	Qualifications not distinguished.	561	
Freemen - - -		2	
Total - - -	329	563	234

Double entries on Register of 1865-6:—

As £10 Occupiers - - -	4	5	
As £10 Occupier and Freeman -	1		
Actual Number of Electors - - -		558	No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register - 180*

The Parliamentary and Municipal Boundaries of the Borough of Beaumaris are conterminous, but the Borough itself is contributory only in sending Members to Parliament.

The above Returns include all the contributory Boroughs.

The Small Tenements Act is in force except in one very small Parish.

The Gross Estimated Rental—	£
In 1856 was - - - - -	24,772
The present Gross Estimated Rental is - - - - -	30,606
Increase - - -	5,834

The Rateable Value—	£	
In 1856 was - -	19,263	Increase since 1856 £7,263
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	22,213	since 1862 £4,313
The present Rateable Value is - - -	26,526	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	34,239
The Gross Estimated Rental of the same description of Property according to the Valuation List is	29,961

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	820
£6 and under £7 - - -	60
£7 and under £8 - - -	128
£8 and under £9 - - -	73
£9 and under £10 - - -	40
£10 and over - - - -	414
	1,535

At a Rateable Value of—	
£4 and under £5 is - - -	269
£5 and under £6 - - - -	138
£6 - - - - - -	66
Above £6 and under £7 - - -	119
£7 and under £8 - - -	47
£8 and under £9 - - - -	55
£9 and under £10 - - -	28
£10 and over - - - -	312

The Gross Estimated Rental it is stated in eight Parishes represents the rent at which rateable property might be reasonably expected to let from year to year, the tenant paying rates, &c., in two parishes, Amlwch and Llangefni, about 10 per cent. less, and in Holyhead it is stated to be always below the rack rent.

In the Parishes of Beaumaris, Llanddona, Llandegfan, Llanfaes, Llanfihangel-din-Sylwy, Llaniestyn, and Penmon a deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, in the Parish of Holyhead a deduction of 20 per cent. is made, and in the Parishes of Amlwch and Llangefni of 10 per cent.

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* In the contributory borough of Holyhead there are a large number of mechanics, artizans, and labourers on the Register who are employed in connection with the Holyhead harbour works, the Chester and Holyhead railway, the City of Dublin Company's steam packets, and the workshops and yards for repairing vessels.

188. BRECON.

Population in 1831 - 5,296	Population in 1861	-	5,639	Increase	- 343
	Population in 1866 (computed)	-	5,435	Increase	- 139

Inhabited Houses in 1861 - - 1,227

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - - - -	231	293	62	—
Freemen - - - - -	11	—	—	11
Total - -	242	293	62	11
			Net Increase. 51	

Double entries on Register of 1865–6 :—

As £10 Occupiers - - - - -	12
Actual Number of Electors - -	281

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - 82

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force throughout the Borough.

The Gross Estimated Rental—	£
In 1856 was - - - -	18,775
The present Gross Estimated Rental is - - - - -	22,379
Increase - - - -	3,604

The Rateable Value—	£	
In 1856 was - -	14,006	Increase since 1856 £4,047
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	12,990	since 1862 £5,063
The present Rateable Value is - - - - -	18,053	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	21,261
The Gross Estimated Rental of the same description of Property according to the Valuation List is	20,708

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - -	858
£6 and under £7 - - -	61
£7 and under £8 - - - - -	22
£8 and under £9 - - -	48
£9 and under £10 - - - -	26
£10 and over - - - - -	296
	1,311

At a Rateable Value of—	
£4 and under £5 is - - -	19
£5 and under £6 - - -	20
£6 - - - - -	9
Above £6 and under £7 - - -	44
£7 and under £8 - - -	10
£8 and under £9 - - -	31
£9 and under £10 - - - -	10
£10 and over - - - -	292

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses above £6. In the case of Houses at and under £6 a further deduction of 25 per cent. is made under the Small Tenements Rating Act.

189. CARDIFF

Population in 1831	8,240	Population in 1861	35,541	Increase	27,301
		Population in 1866 (computed)	46,884	Increase	38,644

Inhabited Houses in 1861 - - 5,152

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	233	1,889	1,656	—
Freemen	454	234	—	220
Total	687	2,123	1,656	220
			Net Increase. 1,436	

Double entries on Register of 1865–6:—

As £10 Occupiers	10	51
As £10 Occupiers and Freemen	41	
Actual Number of Electors		2,072

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	662
As Freemen	122
Total	784
Deduct Double entries	9
Net Number	775

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in three of the four Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was	102,593
The present Gross Estimated Rental is	188,417
Increase	85,824

The Rateable Value—	£	
In 1856 was	79,692	Increase since 1856 £75,569
In 1862 immediately before the date of the Union Assessment Committee Act it was	131,594	
The present Rateable Value is	155,261	since 1862 £23,667

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	150,338
The Gross Estimated Rental of the same description of Property according to the Valuation List is	133,027

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	457
£6 and under £7	401
£7 and under £8	266
£8 and under £9	323
£9 and under £10	93
£10 and over	3,425
	4,965

At a Rateable Value of—	
£4 and under £5 is	182
£5 and under £6	399
£6	67
Above £6 and under £7	370
£7 and under £8	151
£8 and under £9	259
£9 and under £10	202
£10 and over	3,063

The Gross Estimated Rental is stated to represent the full rack rent.

In the Parishes of St. John and St. Mary, Cardiff, a deduction of 12½ per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, in the Parish of Cowbridge 12½ per cent. on Houses above £8, and 15 per cent. on Houses at and under £8, and in the Parish of Llantrissant 12½ per cent. on Houses above £6, and 15 per cent. on Houses at and under £6.

190. CARDIGAN.

Population in 1831	10,003	Population in 1861	11,646	Increase	1,643
		Population in 1866 (computed)	11,589	Increase	1,586

Inhabited Houses in 1861 - - - 2,580

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	466	637	171	—
Freemen or Burgesses	564	55	—	509
Total	1,030	692	171	509
			Net Decrease. 338	

Double entries on Register o 1865-6 :—

As £10 Occupier	1	7
As £10 Occupiers and Freemen	6	
Actual Number of Electors		685

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	83
As Freemen or Burgesses	5
Total	88
Deduct Double Entry	1
Net Number	87

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in six of the eight Parishes within the Borough.

The Gross Estimated Rental—	£
In 1856 was	28,070
The present Gross Estimated Rental is	30,786
Increase	2,716

The Rateable Value—	£	
In 1856 was	24,000	Increase since 1856 £4,999
In 1862 immediately before the date of the Union Assessment Committee Act it was	27,386	since 1862 £1,613
The present Rateable Value is	28,999	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	34,468*
The Gross Estimated Rental of the same description of Property according to the last Poor Rate is	30,297*

The Number of Male Occupiers :—

At a Gross Estimated Rental—	
Under £6 is	1,018
£6 and under £7	104
£7 and under £8	89
£8 and under £9	62
£9 and under £10	61
£10 and over	570
	1,904

At a Rateable Value of—	
£4 and under £5 is	158
£5 and under £6	174
£6	27
Above £6 and under £7	92
£7 and under £8	97
£8 and under £9	45
£9 and under £10	69
£10 and over	476

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parishes of Cenarth and Llandyfriog, 20 per cent. in the Parishes of St. Dogmell and St. Mary, and 10 per cent. in the Parishes of Vaenor Lower, Aberystwith, and Issayndre. In Lampeter no scale has as yet been adopted.

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* The Surveyor of Taxes has included in his Return the whole of the Parish of Lampeter, although part only is within the Borough, as the assessment for the Parish does not distinguish the property beyond the Borough limits. The Return of the Clerk to the Guardians applies only to the part of the Parish within the Borough boundary. The difference between the two Returns is £2,681.

The Clerk of the Aberystwith Union states that the Return of the Surveyor includes property which is not rateable to the Poor Rate, although liable to Income Tax.

191. CARMARTHEN.

Population in 1831	14,340	Population in 1861	21,439	Increase	7,099
		Population in 1866 (computed)	22,635	Increase	8,295

Inhabited Houses in 1861 - - - 3,963

Number of Electors on Parliamentary Register :—

	1832–3.	1864–5.*	Increase.	Decrease.
£10 Occupiers	—	775	775	—
Freemen	280	41	—	239
Scot and Lot Voters	404	—	—	404
Total	684	816	775	643
			Net Increase. 132	

Double entries on Register of 1865–6 :—

As £10 Occupiers and Freemen	25
Actual Number of Electors	791

No Contest at the last General Election.

Number of Working Classes on the Parliamentary Register 1864–5 :—

As £10 Occupiers - - - 152*

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force.

The Gross Estimated Rental—	£
In 1856 was	58,405
The present Gross Estimated Rental is	67,902
Increase	9,497

The Rateable Value—	£	
In 1856 was	40,773	Increase since 1856 £16,366
In 1862 immediately before the date of the Union Assessment Committee Act it was	46,677	since 1862 £10,462
The present Rateable Value is	57,139	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	59,063
The Gross Estimated Rental of the same description of Property according to the Valuation List is	57,309

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	1,081
£6 and under £7	444
£7 and under £8	266
£8 and under £9	175
£9 and under £10	78
£10 and over	979
	3,023

At a Rateable Value of—	
£4 and under £5 is	464
£5 and under £6	404
£6	279
Above £6 and under £7	69
£7 and under £8	160
£8 and under £9	137
£9 and under £10	22
£10 and over	818

The Gross Estimated Rental is stated to represent the full rack rent.

In the Parish of Llanelly a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses under £7, and of 15 per cent. for Houses at and over £7 ; and in the Parish of Carmarthen a deduction of 25 per cent. for Houses under £6, and of 15 per cent. for Houses at and above £6.

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* The Parliamentary Register for 1865–6 was not printed when the Returns were applied for.

192. CARNARVON.

Population in 1831	16,288	Population in 1861	22,907	Increase	6,619
		Population in 1866 (computed)	23,264	Increase	6,976

Inhabited Houses in 1861 - - 4,929

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.
£10 Occupiers	Qualifications not distinguished.	1,027	
Scot and Lot Voters		66	
Total	855	1,093	238

Double entries on Register of 1865–6:—

As £10 Occupiers and Scot and Lot Voters	23	No Contest at the last General Election.
Actual Number of Electors	1,070	

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers	177
As Scot and Lot Voters	31
Total	208

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act has been adopted in 9 of the 11 Parishes.

The Gross Estimated Rental—	£
In 1856 was	50,388
The present Gross Estimated Rental is	57,798
Increase	7,410

The Rateable Value—	£	
In 1856 was	39,712	Increase since 1856 £5,973
In 1862 immediately before the date of the Union Assessment Committee Act it was	42,416	since 1862 £3,269
The present Rateable Value is	45,685	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	62,253*
The Gross Estimated Rental of the same description of Property according to the Valuation List is	55,893*

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is	2,321
£6 and under £7	248
£7 and under £8	205
£8 and under £9	163
£9 and under £10	94
£10 and over	1,078
	4,109

At a Rateable Value of—	
£4 and under £5 is	387
£5 and under £6	240
£6	75
Above £6 and under £7	115
£7 and under £8	141
£8 and under £9	108
£9 and under £10	92
£10 and over	828

The Gross Estimated Rental it is stated, in the Parishes in the Pwllheli Union, represents the full rack rent. In the Parishes in the Carnarvon and Conway Unions it is stated to be what the property might reasonably be expected to let for from year to year, the tenant taking upon himself the usual tenant's rates and taxes.

A deduction of 25 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10 in the Parishes of Bangor, Conway, Conway in Rhos, Conway in Gyffin, Dygyfylchi, and Llandegai; and of 22½ per cent. for Houses at and under £6, and 20 per cent. for Houses over £6, in the Parishes of Abererch, Criccieth, Denio, Llannor, Nevin, and Llanbeblig.

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* There is a difference of £2,012 between the Returns of Income Tax Assessment and Gross Estimated Rental for the Contributory Boroughs of Criccieth, Nevin, and Pwllheli. In Criccieth alone the difference is £1,933, and nearly the full amount is accounted for by the Surveyor of Taxes including in his Return the whole of the Parish, part only being within the Borough. The Return of the Clerk to the Guardians excludes the part not within the Borough boundary.

193. DENBIGH.

Population in 1831	15,616	Population in 1861	17,888	Increase	2,272
		Population in 1866 (computed)	18,561	Increase	2,945

Inhabited Houses in 1861 - - 3,689

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	350	805	455	—
Freemen	781	129	—	652
Total	1,131	934	455	652
			Net Decrease. 197	

Double entries on Register of 1865-6 :—

As £10 Occupiers and Freemen	31
Actual Number of Electors	903

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	86
As Freemen	76
Total	162
Deduct Double entries	7
Net Number	155

Number of Burgesses	2,469
Number of Burgesses whose Rates are assessed on or compounded for by the Owner	1,757
Number of Burgesses on the Parliamentary Register	888

The Small Tenements Act is in force throughout all the contributory Boroughs.

The Gross Estimated Rental—	£
In 1856 was	60,595
The present Gross Estimated Rental is	64,188
Increase	3,593

The Rateable Value—	£	
In 1856 was	48,687	Decrease since 1856 £4,044
In 1862 immediately before the date of the Union Assessment Committee Act it was	42,265	
The present Rateable Value is	44,643	since 1862 £2,378

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	63,631
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is	62,765*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	2,016
£6 and under £7	138
£7 and under £8	112
£8 and under £9	121
£9 and under £10	73
£10 and over	994
	3,454

At a Rateable Value of—	
£4 and under £5 is	282
£5 and under £6	128
£6	70
Above £6 and under £7	96
£7 and under £8	133
£8 and under £9	75
£9 and under £10	69
£10 and over	746

The Gross Estimated Rental is stated to represent the full rack rent.

In five Parishes a deduction of 10 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, in four Parishes the deduction is about 15 per cent., and in two Parishes 20 per cent. No Return received for the Parish of Llanfwrog.

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* With regard to the Parishes in the Wrexham Union it is stated that as the Gross Estimated Rental is not ascertained by a return of the actual rent by the tenant, but is assumed or fixed by a valuer or the overseers, the Income Tax Assessment affords more reliable information as to the *gross* value of the Property.

194. FLINT.

Population in 1831 -	16,126	Population in 1861 -	18,845	Increase -	2,719
		Population in 1866 (computed) -	18,861	Increase -	2,735

Inhabited Houses in 1861 - - 4,188

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	383	601	218	—
Scot and Lot Voters - -	976	99	—	877
Total - -	1,359	700	218	877
			Net Decrease. 659	

Double entries on Register of 1865–6 :—

As £10 Occupiers and Scot and Lot Voters	11	No Contest at the last General Election.
Actual Number of Electors -	689	

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	161
As Scot and Lot Voters - - - -	51
Total - - - - -	212
Deduct Double entries - -	6
Net Number - - -	206

The Parliamentary and Municipal Boundaries of the Borough of Flint are conterminous, but the Borough is contributory only in returning Members to Parliament.

The Small Tenements Act is in force in all the Parishes except Overton.

The Gross Estimated Rental—	£
In 1856 was - - - - -	55,058
The present Gross Estimated Rental is - - - - -	59,532
Increase - - - -	4,474

The Rateable Value—	£	
In 1856 was - -	45,202	Increase since 1856 £5,023
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	37,077	since 1862 £13,148
The present Rateable Value is - - -	50,225	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	52,362
The Gross Estimated Rental of the same description of Property according to the Valuation List is	52,425

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - - -	2,319
£6 and under £7 - - - -	136
£7 and under £8 - - - - -	76
£8 and under £9 - - -	91
£9 and under £10 - - -	29
£10 and over - - - - -	751
	3,402

At a Rateable Value of—*	
£4 and under £5 is - - -	366
£5 and under £6 - - - -	87
£6 - - - - - -	22
Above £6 and under £7 - -	77
£7 and under £8 - - - - -	49
£8 and under £9 - - - - -	24
£9 and under £10 - - - -	79
£10 and over - - - - -	646

The Gross Estimated Rental is stated to represent the full rack rent.

In 5 Parishes a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10; in one Parish (Overton) 12½ per cent. is deducted, in another Parish (Hope) about 15 per cent. is deducted, and in the remaining 5 Parishes 10 per cent. is deducted for Houses at and above £10, 15 per cent. for Houses at £6 and under £10, and 20 per cent. for Houses under £6.

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* In Holywell and Mold the names of the Occupiers of 107 of the tenements at £4 and under £5, and 9 at £5 and under £6, do not appear in the Valuation Lists, and in these cases the number of tenements and not the number of Male Occupiers is given.

195. HAVERFORDWEST.

Population in 1831 - 8,359	Population in 1861	-	9,821	Increase -	1,462
	Population in 1866 (computed)	-	9,867	Increase -	1,508

Inhabited Houses in 1861 - - - 2,102

Number of Electors on Parliamentary Register :—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers - -	—	406	406	—
Freemen - - -	184	191	7	—
Scot and Lot Voters - -	539	215	—	324
Total - -	723	812	413	324
			Net Increase. 89	

Double entries on Register of 1865-6 :—			
As £10 Occupiers - -	2	143	Number who voted at the last General Election.
As £10 Occupiers, Freemen, or Scot and Lot Voters - -	141		
Actual Number of Electors - -		669	549

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - - - -	116
As Freemen - - - - -	113
As Scot and Lot Voters - - -	82
Total - - -	311
Deduct Double entries - -	66
Net Number - - -	245

The Parliamentary and Municipal Boundaries are not conterminous.

The Small Tenements Act is in force in 7 of the 8 Parishes.

The Gross Estimated Rental—	£
In 1856 was - - - -	26,343
The present Gross Estimated Rental is - - - - -	27,153
Increase - - -	810

The Rateable Value—	£	
In 1856 was - -	20,522	Increase since 1856 £440
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	22,496	
The present Rateable Value is - - -	20,962	Decrease since 1862 £1,534

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - -	28,167
The Gross Estimated Rental of the same description of Property according to the Valuation List is	26,552

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	890
£6 and under £7 - - -	154
£7 and under £8 - - - - -	88
£8 and under £9 - - -	55
£9 and under £10 - - -	36
£10 and over - - -	512
	1,735

At a Rateable Value of—	
£4 and under £5 is - - -	323
£5 and under £6 - - -	146
£6 - - - - - -	37
Above £6 and under £7 - -	53
£7 and under £8 - - -	66
£8 and under £9 - - - -	86
£9 and under £10 - - - -	39
£10 and over - - -	425

The Gross Estimated Rental is stated to represent the full rack rent.

In the several Parishes, with the exception of Narberth, a deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses under £6, and 15 per cent. for Houses at and over £6, and in the Parish of Narberth the deduction is 25 per cent. for Houses under £6, and 15 per cent. for Houses above £6.

196. MERTHYR TYDFIL.

Population in 1831	27,281	Population in 1861	83,875	Increase	56,594
		Population in 1866 (computed)	96,717	Increase	69,436

Inhabited Houses in 1861 - - 16,114

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.
£10 Occupiers - - -	502	1,387	885
Actual Number of Electors - - -		1,387	No Contest at the last General Election.

(No Double entries on Register.)

Number of Working Classes on the present Parliamentary Register - - 126*

The Small Tenements Act is in force throughout the whole Borough.

The Gross Estimated Rental—	£
In 1856 was - - - -	180,585
The present Gross Estimated Rental is - - - -	371,742
Increase - - -	191,157

The Rateable Value—	£	
In 1856 was - -	157,360	Increase since 1856 £130,890
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	202,265	since 1862 £85,985
The present Rateable Value is - - -	288,250	

The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - - - £ 175,096

The Gross Estimated Rental of the same description of Property according to the Valuation List is 132,501†

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - - -	9,575
£6 and under £7 - - -	2,605
£7 and under £8 - - -	370
£8 and under £9 - - -	282
£9 and under £10 - - -	131
£10 and over - - - -	1,588
	14,551

At a Rateable Value of—	
£4 and under £5 is - - -	3,085
£5 and under £6 - - -	2,549
£6 - - - - - - -	378
Above £6 and under £7 - -	53
£7 and under £8 - - -	178
£8 and under £9 - - -	155
£9 and under £10 - - -	79
£10 and over - - -	1,522

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £6, and 15 per cent. in the case of all other Houses.

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* With reference to the small number of the Working Classes on the Register it is stated that the borough is inhabited almost entirely by persons engaged in coal and iron works. The persons so employed have amongst them very few mechanics or skilled artizans, the coal of course employing none scarcely, and the iron very few, as the iron is only made into plates, bars, and rails.

† The Poor Rate Assessments in many of the properties have been considerably reduced since the Income Tax Assessment was made in consequence of the stoppage of some of the works. And in estimating the Gross Estimated Rental for cottage property the Poor Rates are taken out at once, whereas in the Income Tax Assessment no allowance is made unless claimed by the landlord. In Aberdare alone there are between 5,000 and 6,000 cottages.

197. MONTGOMERY.

Population in 1831	17,272	Population in 1861	18,036	Increase	764
		Population in 1866 (computed)	18,111	Increase	839

Inhabited Houses in 1861 - - 4,077

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers	657	954	297	—
Freemen	66	61	—	5
Total	723	1,015	297	5
			Net Increase. 292	

Double entries on Register of 1865–6 :—

As £10 Occupiers	19	50	Number who voted at the last General Election.
As £10 Occupiers and Freemen	31		
Actual Number of Electors		965	809

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	171
As Freemen	40
Total	211
Deduct double entries	14
Net Number	197*

The Small Tenements Act appears to be in force in 9 of the 12 Parishes within the Borough.

The Gross Estimated Rental—	£	**The Rateable Value—**	£	
In 1856 was	64,910	In 1856 was	50,188	Increase since 1856 £12,007
The present Gross Estimated Rental is	67,074	In 1862 immediately before the date of the Union Assessment Committee Act it was	58,168	
Increase	2,164	The present Rateable Value is	62,195	since 1862 £4,027

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	66,924
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is	63,198

The Number of Male Occupiers :—

At a Gross Estimated Rental of—		At a Rateable Value of—	
Under £6 is	1,997	£4 and under £5 is	424
£6 and under £7	158	£5 and under £6	167
£7 and under £8	131	£6	105
£8 and under £9	89	Above £6 and under £7	68
£9 and under £10	64	£7 and under £8	82
£10 and over	984	£8 and under £9	123
		£9 and under £10	58
	3,423	£10 and over	840

The Gross Estimated Rental it is stated in 9 Parishes represents the full rack rent, but with regard to the Parish of Llanidloes (part) it is stated that the Gross Estimated Rental as appearing in the Rate Book is very irregular.

In one Parish a deduction of $7\frac{1}{2}$ per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, in three Parishes a deduction of $12\frac{1}{2}$ per cent., in one Parish of from 10 to 25 per cent., and in four Parishes of 15 per cent. for Houses above £6, and 20 per cent. for Houses at or under £6. In the Parish of Llanidloes (part), for which the Valuation List is not completed, the average deductions have been over 35 per cent.

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* With reference to the number of the Working Classes on the Register in the contributory borough of Montgomery it is stated that Montgomery is a small town in an agricultural district, and that the majority of the freemen of the borough are day labourers, and for the most part agricultural labourers.

198. PEMBROKE.

Population in 1831	11,150	Population in 1861	21,773	Increase	10,623
		Population in 1866 (computed)	24,861	Increase	13,711

Inhabited Houses in 1861 - - 3,434

Number of Electors on Parliamentary Register:—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	341	1,102	761	—
Freemen - - -	867	377	—	490
Total - -	1,208	1,479	761	490
			Net Increase, 271	

Double entries on Register of 1865–6:—

As £10 Occupier - -	1	46	Number who voted at the last General Election.
As £10 Occupiers and Freemen	45		
Actual Number of Electors - -		1,433	972

Number of Working Classes on the present Parliamentary Register:—

As £10 Occupiers - - -	515
As Freemen - - - -	284
Total - - -	799*
Deduct double entries - -	23
Net number - - -	776

The Parliamentary and Municipal Boundaries of the Borough of Pembroke are conterminous, but Pembroke is only one of several contributory boroughs included in this Summary.

The Small Tenements Act has been adopted in 5 of the 7 Parishes comprising these contributory boroughs.

The Gross Estimated Rental—	£
In 1856 was - - - -	46,495
The present Gross Estimated Rental is - - - - -	67,960
Increase - -	21,465

The Rateable Value—	£	
In 1856 was - - -	34,266	Increase since 1856 £24,558
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	34,992	since 1862 £23,832
The present Rateable Value is - - - - -	58,824	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	60,908
The Gross Estimated Rental of the same description of Property according to the Valuation List is	59,773

The Number of Male Occupiers:—

At a Gross Estimated Rental of—	
Under £6 is - - - -	1,138
£6 and under £7 - - - -	366
£7 and under £8 - - - -	260
£8 and under £9 - - - -	186
£9 and under £10 - - -	137
£10 and over - - -	1,355
	3,442

At a Rateable Value of—	
£4 and under £5 is - - -	639
£5 and under £6 - - -	288
£6 - - - -	73
Above £6 and under £7 - -	167
£7 and under £8 - - -	146
£8 and under £9 - - -	211
£9 and under £10 - - -	134
£10 and over - - -	1,066

The Gross Estimated Rental is stated to represent the full rack rent.

A deduction of 20 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £6, and of 15 per cent. for Houses above £6.

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* The Return for the Parish in the Pembroke Union was returned with a request that the occupations of the Voters belonging to the Working Class might be entered in the Register. It was stated that the persons included were principally workmen supporting themselves by daily manual labour in Her Majesty's Dockyard at Pembroke, and that it would be impossible to ascertain the separate occupations of the Voters in the time that could be allowed for the purpose.

199. RADNOR, NEW

Population in 1831	6,400	Population in 1861	7 106	Increase	706
		Population in 1866 (computed)	7 344	Increase	944

Inhabited Houses in 1861 - - 1,423

Number of Electors on Parliamentary Register:—

	1832-3.	1865-6.	Increase.	Decrease.
£10 Occupiers	253	420	167	—
Freemen	276	24	—	252
Total	529	444	167	252

Net Decrease. 85

Double entries on Register of 1865-6 :—

As £10 Occupiers and Freemen	3
Actual Number of Electors	441

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers	51
As Freemen	1
Total	52

The Small Tenements Act is in force in the Parish of Knighton. The 59 Geo. 3. c. 12. sect. 19. is stated to have been adopted in the Parish of Presteigne. There does not appear to be any Act in force for rating the Owners in the remaining 20 Parishes.

The Gross Estimated Rental—	£
In 1856 was	30,781
The present Gross Estimated Rental is	36,605
Increase	5,824

The Rateable Value—	£	
In 1856 was	26,147	Increase since 1856 £9,299
In 1862 immediately before the date of the Union Assessment Committee Act it was	29,343	since 1862 £6,103
The present Rateable Value is	35,446	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is	40,014*
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is	36,269*

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is	472
£6 and under £7	73
£7 and under £8	21
£8 and under £9	27
£9 and under £10	21
£10 and over	424
	1,038

At a Rateable Value of—	
£4 and under £5 is	261
£5 and under £6	55
£6	15
Above £6 and under £7	25
£7 and under £8	51
£8 and under £9	23
£9 and under £10	41
£10 and over	410

In the several Parishes, with the exception of Cefnllys, Cwmtoyddwr, and Rhayader, the Gross Estimated Rental it is stated represents the full rack rent. In the Parishes named it is stated that the Gross Estimated Rental does not in every instance represent the full rack rent, and that there is no fixed principle upon which it is computed.

In ten Parishes a deduction of 15 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10; in three Parishes 20 per cent. ; in four Parishes 25 per cent.; and in two Parishes there is no fixed scale of deduction.

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* With reference to the Income Tax Assessment for the Township of Hampton it is stated that it includes the Tithe Rentcharge for the whole Parish of Old Radnor, whilst in the Valuation Lists the Tithe Rentcharge is apportioned amongst the several Parishes, several of which are not within the borough.

200. SWANSEA.

Population in 1831 - 27,134	Population in 1861	-	57,488	Increase -	30,354
	Population in 1866 (computed)	-	64,888	Increase -	37,754

Inhabited Houses in 1861 - - 10,636

Number of Electors on Parliamentary Register :—

	1832–3.	1865–6.	Increase.	Decrease.
£10 Occupiers - -	826	1,695	869	—
Freemen - - - -	481	312	—	169
Total - - -	1,307	2,007	869	169

Net Increase.
700

Double entries on Register of 1865–6 :—

As £10 Occupiers and Freemen - -	40
Actual Number of Electors - -	1,967

No Contest at the last General Election.

Number of Working Classes on the present Parliamentary Register :—

As £10 Occupiers - - -	366
As Freemen - - - - -	96
Total - - -	462
Deduct double entry - -	1
Net number - - -	461

The Parliamentary and Municipal Boundaries of the single Borough of Swansea are conterminous; but Swansea is only one of five contributory Boroughs included in the Summary.

The Small Tenements Act is in force in 8 of the 15 Parishes.

The Gross Estimated Rental—	£
In 1856 was - - -	105,482
The present Gross Estimated Rental is - - - - -	193,743
Increase - - -	88,261

The Rateable Value—	£	
In 1856 was - -	91,634	Increase since 1856 £66,736
In 1862 immediately before the date of the Union Assessment Committee Act it was - -	111,655	since 1862 £46,715
The present Rateable Value is - - -	158,370	

	£
The Gross Annual Value of all Messuages or Tenements and Lands, including Tithe Rentcharge, according to the Income Tax Assessment, Schedule A., is - - - - -	149,767
The Gross Estimated Rental of the same description of Property according to the Valuation List or last Poor Rate is - - - - - - - - -	155,119

The Number of Male Occupiers :—

At a Gross Estimated Rental of—	
Under £6 is - - -	5,099
£6 and under £7 - - -	1,262
£7 and under £8 - - -	714
£8 and under £9 - - -	437
£9 and under £10 - - -	316
£10 and over - - - -	2,873
	10,701

At a Rateable Value of—	
£4 and under £5 is - - -	432
£5 and under £6 - - -	357
£6 - - - - -	110
Above £6 and under £7 - -	556
£7 and under £8 - - -	252
£8 and under £9 - - -	503
£9 and under £10 - - -	132
£10 and over - - -	2,632

The Gross Estimated Rental it is stated represents the full rack rent in all the Parishes except Llansamlet, Lower and Higher, in which it is 12 per cent. less.

In one Parish a deduction of 5 per cent. is made from the Gross Estimated Rental in estimating the Rateable Value of Houses at and under £10, in five Parishes 10 per cent., in one Parish 11 per cent., in one Parish 12½ per cent., in two Parishes 15 per cent., in three Parishes 20 per cent., in one Parish 12½ per cent. for Houses above £8, and 15 per cent. for Houses at and under £8, and in one Parish 15 per cent. for Houses at and over £7, and 20 per cent. for Houses under £7.

A LIST showing the NUMBER of MEMBERS for the BOROUGHS in ENGLAND and WALES.

	Number of Members.
ENGLAND.	
Abingdon	1
Andover	2
Arundel	1
Ashburton	1
Ashton-under-Lyne	1
Aylesbury	2
Banbury	1
Barnstaple	2
Bath	2
Bedford	2
Berwick-upon-Tweed	2
Beverley	2
Bewdley	1
Birkenhead	1
Birmingham	2
Blackburn	2
Bodmin	2
Bolton	2
Boston	2
Bradford (Yorkshire)	2
Bridgnorth	2
Bridgwater	2
Bridport	2
Brighton	2
Bristol	2
Buckingham	2
Bury	1
Bury St. Edmunds	2
Calne	1
Cambridge	2
Canterbury	2
Carlisle	2
Chatham	1
Cheltenham	1
Chester	2
Chichester	2
Chippenham	2
Christchurch	1
Cirencester	2
Clitheroe	1
Cockermouth	2
Colchester	2
Coventry	2
Cricklade	2
Dartmouth	1
Derby	2
Devizes	2
Devonport	2
Dorchester	2
Dover	2
Droitwich	1
Dudley	1
Durham	2
Evesham	2
Exeter	2
Eye	1
Finsbury	2
Frome	1
Gateshead	1
Gloucester	2
Grantham	2
Greenwich	2
Grimsby, Great	1
Guildford	2
Halifax	2
Harwich	2
Hastings	2
Helston	1
Hereford	2
Hertford	2
Honiton	2
Horsham	1
Huddersfield	1
Huntingdon	2
Hythe	1
Ipswich	2
Ives, St.	1
Kendal	1
Kidderminster	1
King's Lynn	2
Kingston-upon-Hull	2
Knaresborough	2
Lambeth	2
Lancaster	2
Launceston	1
Leeds	2
Leicester	2
Leominster	2
Lewes	2
Lichfield	2
Lincoln	2
Liskeard	1
Liverpool	2
London	4
Ludlow	2
Lyme Regis	1
Lymington	2
Macclesfield	2
Maidstone	2
Maldon	2
Malmesbury	1
Malton	2
Manchester	2
Marlborough	2
Marlow, Great	2
Marylebone	2
Midhurst	1
Monmouth	1
Morpeth	1
Newark	2
Newcastle-under-Lyme	2
Newcastle-upon-Tyne	2
Newport (Isle of Wight)	2
Northallerton	1
Northampton	2
Norwich	2
Nottingham	2
Oldham	2
Oxford	2
Penryn and Falmouth	2
Peterborough	2
Petersfield	1
Plymouth	2
Poole	2
Pontefract	2
Portsmouth	2
Preston	2
Reading	2
Reigate	1
Retford, East	2
Richmond	2
Ripon	2
Rochdale	1
Rochester	2
Rye	1
Salford	1
Salisbury	2
Sandwich	2
Scarborough	2
Shaftesbury	1
Sheffield	2
Shoreham, New	2
Shrewsbury	2
Southampton	2
South Shields	1
Southwark	2
Stafford	2
Stamford	2
Stoke-upon-Trent	2
Stockport	2
Stroud	2
Sunderland	2
Tamworth	2
Taunton	2
Tavistock	2
Tewkesbury	2
Thetford	2
Thirsk	1
Tiverton	2
Totnes	2
Tower Hamlets	2
Truro	2
Tynemouth	1
Wakefield	1
Wallingford	1
Walsall	1
Wareham	1
Warrington	1
Warwick	2
Wells	2
Wenlock	2
Westbury (Wilts)	1
Westminster	2
Weymouth and Melcombe Regis	2
Whitby	1
Whitehaven	1
Wigan	2
Wilton	1
Winchester	2
Windsor	2
Wolverhampton	2
Woodstock	1
Worcester	2
Wycombe	2
Yarmouth	2
York	2
WALES.	
Beaumaris	1
Brecknock	1
Cardiff	1
Cardigan	1
Carmarthen	1
Carnarvon	1
Denbigh	1
Flint	1
Haverfordwest	1
Merthyr Tydfil	1
Montgomery	1
Pembroke	1
Radnor	1
Swansea	1

TOTAL - ENGLAND	320
„ WALES	14
TOTAL ENGLAND AND WALES	334

Return G.

COUNTIES.

POPULATION. MALE OCCUPIERS. GROSS ESTIMATED RENTAL, and RATEABLE VALUE. NUMBER of ELECTORS as OCCUPYING TENANTS, and TOTAL NUMBER of ELECTORS on REGISTER, 1832–3, and 1864–5.

Return

COUNTIES. POPULATION. MALE OCCUPIERS.
ELECTORS as OCCUPYING TENANTS, and TOTAL NUMBER of ELECTORS

COUNTY OR ELECTORAL DIVISION OF A COUNTY.	POPULATION.		NUMBER of MALE PERSONS who are assessed in the Valuation Lists now in force Division, or if no Valuation List has been approved then in the Valuation List any Alteration made by them therein, or where there is no such List then in the Building, either with or without Land, within each Parish, at the RATEABLE £15 and under £20, and £20 and under £50, showing the Number of each Class them; and also of the Number of Male Persons in like Manner assessed as Occu- ESTIMATED RENTAL of £50 and upwards, as under :—									
			AT RATEABLE VALUE.									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
	1831.	1861.	Number of Occupiers at £10 and under £12.	Number of Occupiers included in Col. 3. who are both Owners and Occupiers.	Number of Occupiers at £10 and under £12, exclusive of those in Col. 4.	Number of Occupiers at £12 and under £15.	Number of Occupiers included in Col. 6. who are both Owners and Occupiers.	Number of Occupiers at £12 and under £15, exclusive of those in Col. 7.	Number of Occupiers at £15 and under £20.	Number of Occupiers included in Col. 9. who are both Owners and Occupiers.	Number of Occupiers at £15 and under £20, exclusive of those in Col. 10.	Number of Occupiers at £20 and under £50.
ENGLAND.												
BEDFORD - - -	88,524	121,874	651	115	536	476	109	367	636	109	527	953
BERKS - - - -	111,526	128,590	408	63	345	672	121	551	596	123	473	1,177
BUCKINGHAM - - -	104,422	119,073	550	117	433	629	114	515	545	116	429	1,047
CAMBRIDGE - - -	123,038	149,655	894	229	665	800	252	548	831	265	566	1,446
CHESTER:												
NORTHERN DIVISION - -	123,584	182,347	824	92	732	884	118	766	1,104	167	937	2,215
SOUTHERN DIVISION - -	119,432	160,481	1,222	151	1,071	1,198	163	1,035	1,400	215	1,185	2,583
CORNWALL:												
EASTERN DIVISION - -	114,948	136,998	529	127	402	603	134	469	621	144	477	1,669
WESTERN DIVISION - -	137,220	169,614	629	208	421	774	223	551	739	188	551	1,638
CUMBERLAND:												
EASTERN DIVISION - -	72,544	75,972	414	119	295	452	123	329	535	160	375	1,388
WESTERN DIVISION - -	56,115	73,988	365	105	260	335	106	229	395	124	271	842
DERBY:												
NORTHERN DIVISION - -	102,236	159,044	727	141	586	793	154	639	986	175	811	2,104
SOUTHERN DIVISION - -	111,307	137,192	692	157	535	807	180	627	802	196	606	1,337
DEVON:												
NORTHERN DIVISION - -	151,997	150,178	494	133	361	596	140	456	650	177	473	2,025
SOUTHERN DIVISION - -	192,606	220,209	839	163	676	1,141	261	880	1,196	288	908	3,213
DORSET - - - -	114,716	135,695	418	115	303	495	141	354	538	129	409	1,255
DURHAM:												
NORTHERN DIVISION - -	78,151	169,543	660	245	415	612	189	423	757	269	488	955
SOUTHERN DIVISION - -	75,862	170,412	1,458	404	1,054	1,226	318	908	1,354	297	1,057	2,321
ESSEX:												
NORTHERN DIVISION - -	146,747	162,441	443	108	335	607	167	440	608	138	470	1,164
SOUTHERN DIVISION - -	145,401	207,270	1,305	164	1,141	1,883	244	1,639	2,098	261	1,837	3,604

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Gross Estimated Rental, and Rateable Value. Number of on Register, 1832–3, and 1864–5.

for the several Parishes in the County or Electoral last delivered to the Assessment Committee, with last Poor Rate, as Occupiers of a House or other Values of £10 and under £12, £12 and under £15, who are Owners of the Property so occupied by piers of Lands or Tenements, at the Gross						The Amount of the Gross Estimated Rental of all the Property in the County or Electoral Division (excluding Boroughs).			The Amount of the Rateable Value of all the Property in the County or Electoral Division (excluding Boroughs).			Number of Electors on Register.		
		At Gross Estimated Rental.												
13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Number of Occupiers included in Col. 12. who are both Owners and Occupiers.	Number of Occupiers at £20 and under £50, exclusive of those in Col. 13.	Number of Occupiers at £50 and upwards.	Number of Occupiers included in Col. 15. who are both Owners and Occupiers.	Number of Occupiers at £50 and upwards, exclusive of those in Col. 16.	Number of Electors on Register 1864–5 as occupying Tenants at £50 and upwards.	As shown by the Parliamentary Return No. 131, 1860.	As shown by the Valuation Lists or Poor Rate in 1865.	Difference.	As shown by the Parliamentary Return No. 131, 1860.	As shown by the Valuation Lists or Poor Rate in 1865.	Difference.	1832–3.	1864–5.	Difference.
						£	£	Increase. £	£	£	Increase. £			Increase
230	723	1,540	295	1,245	983	465,322	591,685	126,363	406,366	522,108	115,742	3,966	4,845	879
284	893	1,930	586	1,344	1,035	764,058	919,600	155,542	638,442	780,101	141,659	5,582	5,066	516 Decrease.
255	792	1,868	391	1,477	1,277	664,803	809,287	144,484	574,540	707,069	132,529	5,306	6,126	820
548	898	2,834	995	1,839	1,204	959,509	1,105,989	146,480	762,024	934,847	172,823	6,435	7,060	625
406	1,809	2,888	574	2,314	1,626	753,916	985,463	231,547	623,586	852,946	229,360	5,105	6,026	921
454	2,129	3,438	569	2,869	2,019	990,537	1,056,827	66,290	874,491	943,655	69,164	5,130	6,826	1,696
345	1,324	2,203	498	1,705	1,368	513,586	569,422	55,836	419,384	510,593	91,209	4,462	5,781	1,319
368	1,270	1,628	400	1,228	889	402,301	507,766	105,465	329,601	441,290	111,689	3,353	4,615	1,262
425	963	2,233	532	1,701	1,182	386,956	528,690	141,734	341,772	446,769	104,997	4,035	5,455	1,420
247	595	1,617	375	1,242	1,057	304,782	430,651	125,869	269,072	378,863	109,791	3,848	4,602	754
400	1,704	1,922	474	1,448	1,032	510,327	683,378	173,051	429,282	582,452	153,170	4,370	5,055	685
371	966	1,954	407	1,547	1,453	616,919	782,247	165,328	545,117	674,127	129,010	5,541	7,976	2,435
450	1,575	3,810	824	2,986	2,870	813,651	897,971	84,320	609,073	776,541	167,468	5,368	9,592	4,224
822	2,391	4,933	1,200	3,733	2,812	1,106,726	1,291,958	185,232	836,559	1,079,005	242,446	7,453	8,746	1,293
346	909	2,214	518	1,696	1,427	702,888	808,160	105,272	598,148	708,660	110,512	5,632	6,203	571
311	644	1,470	348	1,122	724	496,141	715,918	219,777	437,371	607,753	170,382	4,267	6,042	1,775
521	1,800	2,180	348	1,832	1,150	580,580	988,405	407,825	500,713	840,711	339,998	4,336	7,263	2,927
361	803	2,510	724	1,786	1,229	843,360	937,803	94,443	705,401	823,496	118,095	5,163	4,904	259 Decrease.
603	3,001	3,285	745	2,540	1,481	1,178,643	1,409,194	230,551	924,028	1,201,031	277,003	4,488	7,338	2,850

COUNTY OR ELECTORAL DIVISION OF A COUNTY.	POPULATION.		NUMBER of MALE PERSONS who are assessed in the Valuation Lists now in force Division, or if no Valuation List has been approved then in the Valuation List any Alteration made by them therein, or where there is no such List then in the Building, either with or without Land, within each Parish, at the RATEABLE £15 and under £20, and £20 and under £50, showing the Number of each Class them ; and also of the Number of Male Persons in like Manner assessed as Occu- ESTIMATED RENTAL of £50 and upwards, as under :—									
			AT RATEABLE VALUE.									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
	1831.	1861.	Number of Occupiers at £10 and under £12.	Number of Occupiers included in Col. 3. who are both Owners and Occupiers.	Number of Occupiers at £10 and under £12, exclusive of those in Col. 4.	Number of Occupiers at £12 and under £15.	Number of Occupiers included in Col. 6. who are both Owners and Occupiers.	Number of Occupiers at £12 and under £15, exclusive of those in Col. 7.	Number of Occupiers at £15 and under £20.	Number of Occupiers included in Col. 9. who are both Owners and Occupiers.	Number of Occupiers at £15 and under £20, exclusive of those in Col. 10.	Number of Occupiers at £20 and under £50.
ENGLAND—*continued.*												
GLOUCESTER :												
EASTERN DIVISION - -	87,566	103,804	517	139	378	530	172	358	534	126	408	1,045
WESTERN DIVISION - -	119,982	143,410	655	217	438	735	238	497	762	253	509	1,201
HANTS :												
NORTHERN DIVISION - -	96,387	131,634	449	91	358	543	101	442	490	123	367	1,038
SOUTHERN DIVISION - -	82,358	112,652	674	151	523	800	189	611	874	207	667	1,267
ISLE OF WIGHT - -	28,731	47,428	304	73	231	346	115	231	300	100	200	769
HEREFORD - - - -	94,327	102,321	503	106	403	628	148	480	665	164	501	1,475
HERTFORD - - -	136,984	166,511	778	119	659	1,306	187	1,119	1,037	181	856	1,987
HUNTINGDON - - -	47,779	57,996	305	68	237	326	73	253	346	100	246	621
KENT :												
EASTERN DIVISION - -	130,256	165,261	1,222	207	1,015	1,438	257	1,181	1,508	305	1,203	2,475
WESTERN DIVISION - -	187,335	277,058	2,222	258	1,964	2,822	370	2,452	2,864	350	2,514	5,549
LANCASTER :												
NORTHERN DIVISION - -	259,444	374,489	1,779	314	1,465	2,007	364	1,643	2,197	381	1,816	5,611
SOUTHERN DIVISION - -	363,405	627,656	3,367	381	2,986	4,005	427	3,578	4,620	565	4,055	8,196
LEICESTER :												
NORTHERN DIVISION - -	84,079	92,078	439	83	356	568	131	437	602	119	483	1,134
SOUTHERN DIVISION - -	72,285	77,278	305	74	231	303	82	221	332	77	255	794
LINCOLN :												
PARTS OF LINDSEY - -	155,282	193,757	1,240	413	827	1,424	492	932	1,550	524	1,026	3,268
PARTS OF KESTEVEN AND HOLLAND - - -	118,315	146,602	840	261	579	867	280	587	1,024	354	670	2,199
MIDDLESEX - - -	192,546	368,424	2,327	142	2,185	2,858	202	2,656	4,510	333	4,177	13,436
MONMOUTH - - -	84,541	144,056	529	92	437	545	99	446	851	166	685	1,406
NORFOLK :												
EASTERN DIVISION - -	144,315	148,798	565	166	399	674	185	489	663	196	467	1,315
WESTERN DIVISION - -	146,676	161,218	575	158	417	794	182	612	873	195	678	1,644
NORTHAMPTON :												
NORTHERN DIVISION - -	74,189	91,294	272	62	210	375	112	263	377	109	268	700
SOUTHERN DIVISION - -	81,555	89,553	264	70	194	343	97	246	350	90	260	651

for the several Parishes in the County or Electoral list delivered to the Assessment Committee, with last Poor Rate, as OCCUPIERS of a House or other VALUES of £10 and under £12, £12 and under £15, who are Owners of the Property so occupied by piers of Lands or Tenements, at the GROSS						The AMOUNT of the GROSS ESTIMATED RENTAL of all the PROPERTY in the COUNTY OR ELECTORAL DIVISION (excluding Boroughs).			The AMOUNT of the RATEABLE VALUE of all the PROPERTY in the COUNTY OR ELECTORAL DIVISION (excluding Boroughs).			NUMBER of ELECTORS on REGISTER.		
		AT GROSS ESTIMATED RENTAL.												
13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Number of Occupiers included in Col. 12. who are both Owners and Occupiers.	Number of Occupiers at £20 and under £50, exclusive of those in Col. 13.	Number of Occupiers at £50 and upwards.	Number of Occupiers included in Col. 15. who are both Owners and Occupiers.	Number of Occupiers at £50 and upwards, exclusive of those in Col. 16.	Number of Electors on Register 1864-5 as occupying Tenants at £50 and upwards.	As shown by the Parliamentary Return No. 131, 1860.	As shown by the Valuation Lists or Poor Rate in 1865.	Difference.	As shown by the Parliamentary Return No. 131, 1860.	As shown by the Valuation Lists or Poor Rate in 1865.	Difference.	1832-3.	1864-5.	Difference.
						£	£	Increase. £	£	£	Increase. £			Increase
313	732	2,140	518	1,622	1,340	683,323	803,851	120,528	591,661	699,391	107,730	6,437	7,515	1,078
412	789	2,080	529	1,551	1,364	684,847	762,782	77,935	561,841	668,490	106,649	6,521	9,368	2,847
280	758	1,901	642	1,259	964	628,900	775,982	147,082	525,857	672,940	147,083	2,424	4,185	1,761
373	894	1,291	463	828	469	417,950	542,810	124,860	331,145	456,233	125,088	3,143	5,677	2,534
304	465	424	160	264	333*	185,518	247,696	62,178	154,344	193,452	39,108	1,167	2,362	1,195
384	1,091	2,473	525	1,948	1,743	675,985	825,759	149,774	580,927	722,516	141,589	5,013	7,179	2,166
479	1,508	2,460	758	1,702	1,316	871,259	1,043,599	172,340	726,062	873,363	147,301	4,245	6,228	1,983
186	435	1,146	281	865	598	344,939	438,482	93,543	293,417	391,552	98,135	2,647	2,999	352
634	1,841	2,863	828	2,035	1,440	951,888	1,191,809	239,921	772,858	1,012,982	240,124	7,026	8,250	1,224
700	4,849	6,022	1,382	4,640	2,060	1,358,761	1,901,993	543,232	1,057,803	1,556,138	498,335	6,678	9,811	3,133
842	4,769	5,320	924	4,396	3,961	1,304,991	1,765,011	460,020	1,149,945	1,535,527	385,582	6,593	13,006	6,413
1,078	7,118	8,728	2,329	6,399	4,076	2,193,757	3,074,590	880,833	1,902,485	2,643,411	740,926	10,039	21,555	11,516
275	859	1,850	402	1,448	1,190	493,214	617,887	124,673	435,269	550,616	115,347	3,658	4,767	1,109
215	579	1,824	436	1,388	1,092	479,941	544,968	65,027	422,930	471,421	48,491	4,125	6,283	2,158
1,178	2,090	4,804	1,241	3,563	2,801	1,252,720	1,550,658	297,938	1,091,763	1,414,990	323,227	9,134	12,372	3,238
770	1,429	3,952	1,149	2,803	2,565	1,118,501	1,287,678	169,177	977,566	1,147,534	169,968	7,956	9,260	1,304
1,175	12,261	9,499	1,714	7,785	2,480	1,819,569	2,655,367	835,798	1,411,600	2,230,820	819,220	6,939	14,847	7,908
279	1,127	1,639	313	1,326	1,111	557,283	642,085	84,802	478,306	541,311	63,005	3,738	4,909	1,171
374	941	2,788	808	1,980	1,812	941,816	1,003,289	61,473	785,726	886,823	101,097	7,041	7,939	898
445	1,199	3,100	782	2,318	1,550	1,005,767	1,198,827	193,060	839,788	1,043,430	203,642	4,396	6,534	2,138
257	443	1,629	376	1,253	921	485,943	644,425	158,482	431,591	567,414	135,823	3,363	4,016	653
197	454	1,744	417	1,327	1,005	535,055	690,271	155,216	470,134	596,706	126,572	4,425	5,293	868

* The number of Electors on the Register for the Isle of Wight is not given in the Return No. 448 (1865), and it has been obtained from the Returning Officer.

NUMBER of MALE PERSONS who are assessed in the Valuation Lists now in force Division, or if no Valuation List has been approved then in the Valuation List any Alteration made by them therein, or where there is no such List then in the Building, either with or without Land, within each Parish, at the RATEABLE £15 and under £20, and £20 and under £50, showing the Number of each Class them; and also of the Number of Male Persons in like Manner assessed as Occu- ESTIMATED RENTAL of £50 and upwards, as under :—

COUNTY OR ELECTORAL DIVISION OF A COUNTY.	POPULATION.		AT RATEABLE VALUE.									
	1. 1831.	2. 1861.	3. Number of Occupiers at £10 and under £12.	4. Number of Occupiers included in Col. 3. who are both Owners and Occupiers.	5. Number of Occupiers at £10 and under £12, exclusive of those in Col. 4.	6. Number of Occupiers at £12 and under £15.	7. Number of Occupiers included in Col. 6. who are both Owners and Occupiers.	8. Number of Occupiers at £12 and under £15, exclusive of those in Col. 7.	9. Number of Occupiers at £15 and under £20.	10. Number of Occupiers included in Col. 9. who are both Owners and Occupiers.	11. Number of Occupiers at £15 and under £20, exclusive of those in Col. 10.	12. Number of Occupiers at £20 and under £50.
ENGLAND—*continued.*												
NORTHUMBERLAND:												
NORTHERN DIVISION - -	60,356	65,982	294	41	253	257	44	213	236	46	190	408
SOUTHERN DIVISION - -	79,889	106,855	365	85	280	410	125	285	489	124	365	1,099
NOTTINGHAM:												
NORTHERN DIVISION - -	65,403	88,886	339	66	273	312	68	244	392	87	305	714
SOUTHERN DIVISION - -	59,267	71,443	316	48	268	365	71	294	416	89	327	929
OXFORD - - - -	118,516	125,379	398	77	321	536	113	423	475	126	349	935
RUTLAND - - - -	19,385	21,861	82	15	67	85	20	65	100	25	75	210
SALOP:												
NORTHERN DIVISION - -	98,384	114,247	596	70	526	626	90	536	750	148	602	1,411
SOUTHERN DIVISION - -	64,094	69,346	321	59	262	319	76	243	409	65	344	835
SOMERSET:												
EASTERN DIVISION - -	160,610	172,712	886	234	652	957	268	689	1,183	322	861	2,422
WESTERN DIVISION - -	145,985	159,551	577	172	405	640	189	451	781	198	583	1,799
STAFFORD:												
NORTHERN DIVISION - -	120,319	162,986	895	157	738	957	182	775	1,106	247	859	2,230
SOUTHERN DIVISION - -	129,447	260,262	1,586	332	1,254	1,525	341	1,184	1,916	456	1,460	3,029
SUFFOLK:												
EASTERN DIVISION - -	135,072	146,833	630	166	464	660	176	484	674	161	513	1,412
WESTERN DIVISION - -	119,173	126,634	384	89	295	500	123	377	543	130	413	1,141
SURREY:												
EASTERN DIVISION - -	106,217	209,345	2,582	136	2,446	3,353	185	3,168	3,804	288	3,516	7,190
WESTERN DIVISION - -	81,249	109,546	510	89	421	660	127	533	625	119	506	1,501
SUSSEX:												
EASTERN DIVISION - -	103,744	126,234	582	124	458	766	157	609	766	199	567	1,709
WESTERN DIVISION - -	54,523	53,025	161	42	119	236	65	171	232	72	160	482
WARWICK:												
NORTHERN DIVISION - -	81,336	117,127	1,002	175	827	1,104	186	918	861	190	671	1,402
SOUTHERN DIVISION - -	71,651	90,938	513	94	419	632	144	488	611	138	473	1,235
WESTMORLAND - - -	43,464	48,788	175	42	133	258	83	175	335	90	245	1,13

for the several Parishes in the County or Electoral last delivered to the Assessment Committee, with last Poor Rate, as Occupiers of a House or other Values of £10 and under £12, £12 and under £15, who are Owners of the Property so occupied by piers of Lands or Tenements, at the Gross						The Amount of the Gross Estimated Rental of all the Property in the County or Electoral Division (excluding Boroughs).			The Amount of the Rateable Value of all the Property in the County or Electoral Division (excluding Boroughs).			Number of Electors on Register.		
		At Gross Estimated Rental.												
13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
Number of Occupiers included in Col. 12. who are both Owners and Occupiers.	Number of Occupiers at £20 and under £50, exclusive of those in Col. 13.	Number of Occupiers at £50 and upwards.	Number of Occupiers included in Col. 15. who are both Owners and Occupiers.	Number of Occupiers at £50 and upwards, exclusive of those in Col. 16.	Number of Electors on Register 1864-5 as occupying Tenants at £50 and upwards.	As shown by the Parliamentary Return No. 131, 1860.	As shown by the Valuation Lists or Poor Rate in 1865.	Difference.	As shown by the Parliamentary Return No. 131, 1860.	As shown by the Valuation Lists or Poor Rate in 1865.	Difference.	1832-3.	1864-5.	Difference.
						£	£	Increase. £	£	£	Increase. £			Increase
90	318	1,398	154	1,244	763	520,487	593,932	73,445	496,215	550,799	54,584	2,322	3,109	787
255	844	1,963	284	1,679	1,266	488,813	664,079	175,266	459,026	610,604	151,578	5,192	5,511	319
190	524	781	167	614	443	238,657	322,335	83,678	192,938	266,249	73,311	2,889	4,065	1,176
225	704	1,632	456	1,176	917	430,428	507,494	77,066	372,618	462,486	89,868	3,170	3,427	257
296	639	2,212	510	1,702	1,298	671,957	837,575	165,618	578,828	733,924	155,096	4,721	5,798	1,077
66	144	509	60	449	423	150,012	176,843	26,831	135,317	157,113	21,796	1,296	1,774	478
345	1,066	2,122	447	1,675	1,485	589,091	719,846	130,755	547,782	655,031	107,249	4,682	5,315	633
158	677	1,796	343	1,453	1,375	497,778	576,622	78,844	445,641	520,121	74,480	2,791	4,170	1,379
643	1,779	3,941	958	2,983	2,633	1,058,877	1,292,565	233,688	903,255	1,161,276	258,021	8,996	11,867	2,871
515	1,284	3,321	773	2,548	2,183	900,647	1,034,050	133,403	729,590	925,127	195,537	7,884	8,632	748
436	1,794	3,113	612	2,501	2,110	844,052	1,112,734	268,682	728,857	961,230	232,373	8,756	10,703	1,947
724	2,305	2,458	737	1,721	880	907,642	1,138,125	230,483	772,930	937,830	164,900	3,107	10,841	7,734
406	1,006	2,568	579	1,989	1,719	746,906	891,330	144,424	635,002	763,845	128,843	4,265	6,769	2,504
336	805	2,147	582	1,565	1,159	623,989	752,616	128,627	521,711	670,622	148,911	3,326	4,269	943
890	6,300	5,944	1,400	4,544	2,339	1,159,112	1,886,861	727,749	894,148	1,527,873	633,725	3,150	9,913	6,763
321	1,180	1,591	613	978	720	456,269	590,581	134,312	376,621	506,028	129,407	2,912	4,081	1,169
436	1,273	2,185	722	1,463	1,180	576,066	761,956	185,890	466,665	634,538	167,873	3,437	6,670	3,233
177	305	904	248	656	492	305,697	355,075	49,378	257,117	308,850	51,733	2,365	2,607	242
370	1,032	1,983	493	1,490	967	611,414	774,048	162,634	510,999	649,719	138,720	3,730	6,710	2,980
349	886	2,225	523	1,702	1,055	587,317	734,133	146,816	513,793	645,532	131,739	2,550	3,517	967
275	861	1,720	358	1,362	1,196	307,563	411,185	103,622	269,476	361,565	92,089	4,392	4,237	Decrease 155

COUNTY OR ELECTORAL DIVISION OF A COUNTY.	POPULATION.		NUMBER of MALE PERSONS who are assessed in the Valuation Lists now in force Division, or if no Valuation List has been approved then in the Valuation List any Alteration made by them therein, or where there is no such List then in the Building, either with or without Land, within each Parish, at the RATEABLE £15 and under £20, and £20 and under £50, showing the Number of each Class them; and also of the Number of Male Persons in like Manner assessed as Occu- ESTIMATED RENTAL of £50 and upwards, as under :—									
			AT RATEABLE VALUE.									
	1. 1831.	2. 1861.	3. Number of Occupiers at £10 and under £12.	4. Number of Occupiers included in Col. 3. who are both Owners and Occupiers.	5. Number of Occupiers at £10 and under £12, exclusive of those in Col. 4.	6. Number of Occupiers at £12 and under £15.	7. Number of Occupiers included in Col. 6. who are both Owners and Occupiers.	8. Number of Occupiers at £12 and under £15, exclusive of those in Col. 7.	9. Number of Occupiers at £15 and under £20.	10. Number of Occupiers included in Col. 9. who are both Owners and Occupiers.	11. Number of Occupiers at £15 and under £20, exclusive of those in Col. 10.	12. Number of Occupiers at £20 and under £50.
ENGLAND—*continued.*												
WILTS:												
NORTHERN DIVISION - -	79,940	79,362	212	58	154	259	83	176	325	91	234	598
SOUTHERN DIVISION - -	74,155	73,932	197	56	141	203	54	149	251	59	192	457
WORCESTER:												
EASTERN DIVISION - -	83,151	129,690	897	177	720	953	200	753	935	247	688	1,584
WESTERN DIVISION - -	56,536	67,256	383	101	282	402	102	300	381	99	282	790
YORK:												
EAST RIDING - - -	107,292	127,053	701	170	531	849	203	646	718	186	532	1,523
NORTH RIDING (with the City and Ainstey of the City of YORK) -	160,555	201,004	1,389	253	1,136	1,322	256	1,066	1,671	312	1,359	3,576
WEST RIDING:												
NORTHERN DIVISION, - -	323,684	419,972	1,774	336	1,438	1,881	343	1,538	2,373	389	1,984	5,909
SOUTHERN DIVISION - -	315,057	461,022	2,213	389	1,824	2,348	451	1,897	2,981	530	2,451	5,330
TOTAL - ENGLAND -	8,077,167	10,661,125	54,619	10,454	44,165	62,595	12,285	50,310	70,059	13,792	56,267	143,713
WALES.												
ANGLESEY - - -	37,638	41,334	189	15	174	231	20	211	238	18	220	625
BRECON - - - -	40,967	53,531	271	27	244	291	35	256	404	46	358	1,137
CARDIGAN - - -	56,519	62,354	252	38	214	306	44	262	378	52	326	1,232
CARMARTHEN - - -	85,381	89,439	451	48	403	554	39	515	746	61	685	2,237
CARNARVON - - -	50,530	72,787	300	27	273	444	92	352	469	69	400	1,159
DENBIGH - - - -	67,049	82,890	322	71	251	334	51	283	527	84	443	1,459
FLINT - - - -	44,118	50,892	243	26	217	255	33	222	352	54	298	723
GLAMORGAN - - -	65,457	143,305	629	126	503	724	148	576	818	123	695	1,845
MERIONETH - - -	35,315	38,963	259	45	214	283	49	234	334	33	301	929
MONTGOMERY - - -	49,572	48,883	290	32	258	320	39	281	440	50	390	1,288
PEMBROKE - - -	61,193	63,847	306	25	281	329	33	296	431	24	407	1,072
RADNOR - - - -	18,371	18,305	86	15	71	109	22	87	130	17	113	448
TOTAL - WALES - -	612,110	766,530	3,598	495	3,103	4,180	605	3,575	5,267	631	4,636	14,154
TOTAL - **ENGLAND AND WALES** - -	8,689,277	11,427,655	58,217	10,949	47,268	66,775	12,890	53,885	75,326	14,423	60,903	157,867

for the several Parishes in the County or Electoral last delivered to the Assessment Committee, with last Poor Rate, as OCCUPIERS of a House or other VALUES of £10 and under £12, £12 and under £15, who are Owners of the Property so occupied by piers of Lands or Tenements, at the GROSS

		AT GROSS ESTIMATED RENTAL.				The AMOUNT of the GROSS ESTIMATED RENTAL of all the PROPERTY in the COUNTY or ELECTORAL DIVISION (excluding BOROUGHS).			The AMOUNT of the RATEABLE VALUE of all the PROPERTY in the COUNTY or ELECTORAL DIVISION (excluding BOROUGHS).			NUMBER of ELECTORS on REGISTER.		
13. Number of Occupiers included in Col. 12, who are both Owners and Occupiers.	14. Number of Occupiers at £20 and under £50, exclusive of those in Col. 13.	15. Number of Occupiers at £50 and upwards.	16. Number of Occupiers included in Col. 15, who are both Owners and Occupiers.	17. Number of Occupiers at £50 and upwards, exclusive of those in Col. 16.	18. Number of Electors on Register 1864–5 as occupying Tenants at £50 and upwards.	19. As shown by the Parliamentary Return No. 131, 1860.	20. As shown by the Valuation Lists or Poor Rate in 1865.	21. Difference.	22. As shown by the Parliamentary Return No. 131, 1860.	23. As shown by the Valuation Lists or Poor Rate in 1865.	24. Difference.	25. 1832–3.	26. 1864–5.	27. Difference.
						£	£	Increase. £	£	£	Increase. £			Increase
152	446	1,264	274	990	751	461,424	517,417	55,993	396,192	457,767	61,575	3,614	5,146	1,532
145	312	1,007	214	793	638	416,476	472,820	56,344	353,219	412,958	59,739	2,540	3,343	803
455	1,129	1,902	494	1,408	861	544,362	692,023	147,661	454,529	603,883	149,354	5,161	6,875	1,714
179	611	1,663	416	1,247	1,093	421,784	518,844	97,060	362,547	460,003	97,456	3,122	5,221	2,099
427	1,096	3,552	579	2,973	2,365	960,865	1,213,850	252,985	858,578	1,084,637	226,059	5,559	7,400	1,841
718	2,858	6,151	847	5,304	5,226	1,210,423	1,533,830	323,407	1,027,066	1,364,943	337,877	9,539	15,438	5,899
943	4,966	6,044	1,338	4,706	6,487	3,126,609	1,829,897	875,564	2,613,279	1,580,772	805,704	18,056	40,695	22,639
1,211	4,119	5,072	1,370	3,702			2,172,276			1,838,211				
30,630	113,083	189,302	44,331	144,971	107,033	51,861,649	65,315,175	13,453,526	43,691,927	56,502,613	12,810,686	344,072	501,979	157,907
91	534	616	74	542	573	131,243	166,871	35,628	99,731	147,242	47,511	1,187	2,352	1,165
149	988	892	137	755	633	204,859	241,949	37,090	175,727	209,996	34,269	1,668	2,409	741
164	1,068	633	112	521	820	166,248	169,202	2,954	142,496	142,459	Decrease 37	1,184	3,520	2,336
204	2,033	1,915	278	1,637	1,299	336,185	411,391	75,206	289,363	367,221	77,858	3,887	4,833	946
157	1,002	613	104	509	459	191,471	286,013	94,542	167,541	241,387	73,846	1,688	2,190	502
193	1,266	1,519	254	1,265	1,256	345,327	400,459	55,132	286,900	344,792	57,892	3,401	5,333	1,932
118	605	971	130	841	691	240,725	298,454	57,729	182,427	262,571	80,144	1,271	2,998	1,727
248	1,597	1,622	337	1,285	974	459,394	793,648	334,254	388,462	667,611	279,149	3,680	6,759	3,079
90	839	661	82	579	530	146,086	170,188	24,102	121,344	141,872	20,528	580	1,527	947
156	1,132	1,449	171	1,278	1,284	284,090	311,876	27,786	233,866	282,014	48,148	2,523	3,339	816
123	949	1,286	223	1,063	866	285,130	316,470	31,340	234,389	274,217	39,828	3,700	3,797	97
55	393	698	97	601	442	105,674	129,287	23,613	89,042	111,506	22,464	1,046	1,597	551
1,748	12,406	12,875	1,999	10,876	9,827	2,896,432	3,695,808	799,376	2,411,288	3,192,888	781,600	25,815	40,654	14,839
32,378	125,489	202,177	46,330	155,847	116,860	54,758,081	69,010,983	14,252,902	46,103,215	59,695,501	13,592,286	369,887	542,633	172,746

G. Abstract.

COUNTIES.—ELECTORAL RETURNS.

Table showing the Number of Male Occupiers of a House or other Building, either with or without Land, at the several Rateable Values as under : Also, the Number of Occupiers of Lands or Tenements at the Gross Estimated Rental of £50 and upwards (*exclusive in all cases of those who are both Owners and Occupiers*). And the Number of Electors on the Register 1864–5 as Occupying Tenants at £50 and upwards.

COUNTY OR ELECTORAL DIVISION OF A COUNTY.	AT RATEABLE VALUE OF							Number of Electors on Register 1864–5 as £50 Occupying Tenants.	Male Occupiers at gross estimated Rental of £50 and upwards.	Total Number of Electors on Registe 1864–5.
	£10 and under £12	£12 and under £15	£15 and under £20	£20 and under £50	Total at £10 and under £50	Total at £12 and under £50	Total at £15 and under £50			
ENGLAND.										
BEDFORD - -	536	367	527	723	2,153	1,617	1,250	983	1,245	4,845
BERKS - - -	345	551	473	893	2,262	1,917	1,366	1,035	1,344	5,066
BUCKINGHAM - -	433	515	429	792	2,169	1,736	1,221	1,277	1,477	6,126
CAMBRIDGE - -	665	548	566	898	2,677	2,012	1,464	1,204	1,839	7,060
CHESTER :										
Northern Division -	732	766	937	1,809	4,244	3,512	2,746	1,626	2,314	6,026
Southern Division -	1,071	1,035	1,185	2,129	5,420	4,349	3,314	2,019	2,869	6,826
CORNWALL :										
Eastern Division -	402	469	477	1,324	2,672	2,270	1,801	1,368	1,705	5,781
Western Division -	421	551	551	1,270	2,793	2,372	1,821	889	1,228	4,615
CUMBERLAND :										
Eastern Division -	295	329	375	963	1,962	1,667	1,338	1,182	1,701	5,455
Western Division -	260	229	271	595	1,355	1,095	866	1,057	1,242	4,602
DERBY :										
Northern Division -	586	639	811	1,704	3,740	3,154	2,515	1,032	1,448	5,055
Southern Division -	535	627	606	966	2,734	2,199	1,572	1,453	1,547	7,976
DEVON :										
Northern Division -	361	456	473	1,575	2,865	2,504	2,048	2,870	2,986	9,592
Southern Division -	676	880	908	2,391	4,855	4,179	3,299	2,812	3,733	8,746
DORSET - -	303	354	409	909	1,975	1,672	1,318	1,427	1,696	6,203
DURHAM :										
Northern Division -	415	423	488	644	1,970	1,555	1,132	724	1,122	6,042
Southern Division -	1,054	908	1,057	1,800	4,819	3,765	2,857	1,150	1,832	7,263
ESSEX :										
Northern Division -	335	440	470	803	2,048	1,713	1,273	1,229	1,786	4,904
Southern Division -	1,141	1,639	1,837	3,001	7,618	6,477	4,838	1,481	2,540	7,338
GLOUCESTER :										
Eastern Division -	378	358	408	732	1,876	1,498	1,140	1,340	1,622	7,515
Western Division -	438	497	509	789	2,233	1,795	1,298	1,364	1,551	9,368
HANTS :										
Northern Division -	358	442	367	758	1,925	1,567	1,125	964	1,259	4,185
Southern Division -	523	611	667	894	2,695	2,172	1,561	469	828	5,677
Isle of Wight -	231	231	200	465	1,127	896	665	333	264	2,362
HEREFORD - -	403	480	501	1,091	2,475	2,072	1,592	1,743	1,948	7,179
HERTFORD - -	659	1,119	856	1,508	4,142	3,483	2,364	1,316	1,702	6,228

COUNTY OR ELECTORAL DIVISION OF A COUNTY.	AT RATEABLE VALUE OF							Number of Electors on Register 1864–5 as £50 Occupying Tenants.	Male Occupiers at gross estimated Rental of £50 and upwards.	Total Number of Electors on Register 1864–5.
	£10 and under £12	£12 and under £15	£15 and under £20	£20 and under £50	Total at £10 and under £50	Total at £12 and under £50	Total at £15 and under £50			
ENGLAND—*continued.*										
HUNTINGDON	237	253	246	435	1,171	934	681	598	865	2,999
KENT:										
Eastern Division	1,015	1,181	1,203	1,841	5,240	4,225	3,044	1,440	2,035	8,250
Western Division	1,964	2,452	2,514	4,849	11,779	9,815	7,363	2,060	4,640	9,811
LANCASTER:										
Northern Division	1,465	1,643	1,816	4,769	9,693	8,228	6,585	3,961	4,396	13,006
Southern Division	2,986	3,578	4,055	7,118	17,737	14,751	11,173	4,076	6,399	21,555
LEICESTER:										
Northern Division	356	437	483	859	2,135	1,779	1,342	1,190	1,448	4,767
Southern Division	231	221	255	579	1,286	1,055	834	1,092	1,388	6,283
LINCOLN:										
Parts of Lindsey	827	932	1,026	2,090	4,875	4,048	3,116	2,801	3,563	12,372
Parts of Kesteven and Holland	579	587	670	1,429	3,265	2,686	2,099	2,565	2,803	9,260
MIDDLESEX	2,185	2,656	4,177	12,261	21,279	19,094	16,438	2,480	7,785	14,847
MONMOUTH	437	446	685	1,127	2,695	2,258	1,812	1,111	1,326	4,909
NORFOLK										
Eastern Division	399	489	467	941	2,296	1,897	1,408	1,812	1,980	7,939
Western Division	417	612	678	1,199	2,906	2,489	1,877	1,550	2,318	6,534
NORTHAMPTON:										
Northern Division	210	263	268	443	1,184	974	711	921	1,253	4,016
Southern Division	194	246	260	454	1,154	960	714	1,005	1,327	5,293
NORTHUMBERLAND:										
Northern Division	253	213	190	318	974	721	508	763	1,244	3,109
Southern Division	280	285	365	844	1,774	1,494	1,209	1,266	1,679	5,511
NOTTINGHAM:										
Northern Division	273	244	305	524	1,346	1,073	829	443	614	4,065
Southern Division	268	294	327	704	1,593	1,325	1,031	917	1,176	3,427
OXFORD	321	423	349	639	1,732	1,411	988	1,298	1,702	5,798
RUTLAND	67	65	75	144	351	284	219	423	449	1,774
ALOP:										
Northern Division	526	536	602	1,066	2,730	2,204	1,668	1,485	1,675	5,315
Southern Division	262	243	344	677	1,526	1,264	1,021	1,375	1,453	4,170
OMERSET:										
Eastern Division	652	689	861	1,779	3,981	3,329	2,640	2,633	2,983	11,867
Western Division	405	451	583	1,284	2,723	2,318	1,867	2,183	2,548	8,632
TAFFORD:										
Northern Division	738	775	859	1,794	4,166	3,428	2,653	2,110	2,501	10,703
Southern Division	1,254	1,184	1,460	2,305	6,203	4,949	3,765	880	1,721	10,841
UFFOLK:										
Eastern Division	464	484	513	1,006	2,467	2,003	1,519	1,719	1,989	6,769
Western Division	295	377	413	805	1,890	1,595	1,218	1,159	1,565	4,269

COUNTY OR ELECTORAL DIVISION OF A COUNTY.	AT RATEABLE VALUE OF							Number of Electors on Register 1864–5 as £50 Occupying Tenants.	Male Occupiers at gross estimated Rental of £50 and upwards.	Total Number of Electors on Register 1864–5.
	£10 and under £12	£12 and under £15	£15 and under £20	£20 and under £50	Total at £10 and under £50	Total at £12 and under £50	Total at £15 and under £50			
ENGLAND—*continued.*										
SURREY:										
Eastern Division -	2,446	3,168	3,516	6,300	15,430	12,984	9,816	2,339	4,544	9,913
Western Division -	421	533	506	1,180	2,640	2,219	1,686	720	978	4,081
SUSSEX:										
Eastern Division -	458	609	567	1,273	2,907	2,449	1,840	1,180	1,463	6,670
Western Division -	119	171	160	305	755	636	465	492	656	2,607
WARWICK:										
Northern Division -	827	918	671	1,032	3,448	2,621	1,703	967	1,490	6,710
Southern Division -	419	488	473	886	2,266	1,847	1,359	1,055	1,702	3,517
WESTMORLAND -	133	175	245	861	1,414	1,281	1,106	1,196	1,362	4,237
WILTS:										
Northern Division -	154	176	234	446	1,010	856	680	751	990	5,146
Southern Division -	141	149	192	312	794	653	504	638	793	3,343
WORCESTER:										
Eastern Division -	720	753	688	1,129	3,290	2,570	1,817	861	1,408	6,875
Western Division -	282	300	282	611	1,475	1,193	893	1,093	1,247	5,221
YORK:										
East Riding - -	531	646	532	1,096	2,805	2,274	1,628	2,365	2,973	7,400
North Riding (with the City and Ainstey of the City of York) -	1,136	1,066	1,359	2,858	6,419	5,283	4,217	5,226	5,304	15,43
West Riding:										
Northern Division -	1,438	1,538	1,984	4,966	9,926	8,488	6,950	6,487	4,706	40,69
Southern Division -	1,824	1,897	2,451	4,119	10,291	8,467	6,570		3,702	
Total - ENGLAND	44,165	50,310	56,267	113,083	263,825	219,660	169,350	107,033	144,971	501,979
WALES.										
ANGLESEY - -	174	211	220	534	1,139	965	754	573	542	2,352
BRECON - - -	244	256	358	988	1,846	1,602	1,346	633	755	2,409
CARDIGAN - -	214	262	326	1,068	1,870	1,656	1,394	820	521	3,520
CARMARTHEN -	403	515	685	2,033	3,636	3,233	2,718	1,299	1,637	4,833
CARNARVON - -	273	352	400	1,002	2,027	1,754	1,402	459	509	2,190
DENBIGH - -	251	283	443	1,266	2,243	1,992	1,709	1,256	1,265	5,333
FLINT - - -	217	222	298	605	1,342	1,125	903	691	841	2,998
GLAMORGAN - -	503	576	695	1,597	3,371	2,868	2,292	974	1,285	6,759
MERIONETH - -	214	234	301	839	1,588	1,374	1,140	530	579	1,527
MONTGOMERY -	258	281	390	1,132	2,061	1,803	1,522	1,284	1,278	3,339
PEMBROKE - -	281	296	407	949	1,933	1,652	1,356	866	1,063	3,797
RADNOR - -	71	87	113	393	664	593	506	442	601	1,597
Total - WALES -	3,103	3,575	4,636	12,406	23,720	20,617	17,042	9,827	10,876	40,654
Total - **ENGLAND AND WALES** -	47,268	53,885	60,903	125,489	287,545	240,277	186,392	116,860	155,847	542,63

A List of the Number of Members for the Counties of England and Wales.

	Number of Members.
ENGLAND.	
BEDFORD - -	2
BERKS - -	3
BUCKINGHAM - - -	3
CAMBRIDGE - -	3
CHESTER:	
Northern Division -	2
Southern Division -	2
CORNWALL:	
Eastern Division -	2
Western Division -	2
CUMBERLAND:	
Eastern Division -	2
Western Division -	2
DERBY:	
Northern Division -	2
Southern Division -	2
DEVON:	
Northern Division -	2
Southern Division -	2
DORSET - -	3
DURHAM:	
Northern Division -	2
Southern Division -	2
ESSEX:	
Northern Division -	2
Southern Division -	2
GLOUCESTER:	
Eastern Division -	2
Western Division -	2
HANTS:	
Northern Division -	2
Southern Division -	2
Isle of Wight -	1
HEREFORD - -	3
HERTFORD - -	3
HUNTINGDON - -	2
KENT:	
Eastern Division -	2
Western Division -	2
LANCASTER:	
Northern Division -	2
Southern Division -	3
LEICESTER:	
Northern Division -	2
Southern Division -	2
LINCOLN:	
Parts of Lindsey -	2
Parts of Kesteven and Holland - -	2
MIDDLESEX - -	2
MONMOUTH - -	2
NORFOLK:	
Eastern Division -	2
Western Division -	2
NORTHAMPTON:	
Northern Division -	2
Southern Division -	2
NORTHUMBERLAND:	
Northern Division -	2
Southern Division -	2
NOTTINGHAM:	
Northern Division -	2
Southern Division -	2
OXFORD - - -	3
RUTLAND - -	2
SALOP:	
Northern Division -	2
Southern Division -	2
SOMERSET:	
Eastern Division -	2
Western Division -	2
STAFFORD:	
Northern Division -	2
Southern Division -	2
SUFFOLK:	
Eastern Division -	2
Western Division -	2
SURREY:	
Eastern Division -	2
Western Division -	2
SUSSEX:	
Eastern Division -	2
Western Division -	2
WARWICK:	
Northern Division -	2
Southern Division -	2
WESTMORLAND - -	2
WILTS:	
Northern Division -	2
Southern Division -	2
WORCESTER:	
Eastern Division -	2
Western Division -	2
YORK:	
East Riding - -	2
North Riding (with the City and Ainstey of the City of York) -	2
West Riding:	
Northern Division -	2
Southern Division -	2
Total - ENGLAND	147
WALES.	
ANGLESEY - -	1
BRECON - - -	1
CARDIGAN - -	1
CARMARTHEN - -	2
CARNARVON - -	1
DENBIGH - - -	2
FLINT - - -	1
GLAMORGAN - -	2
MERIONETH - -	1
MONTGOMERY - -	1
PEMBROKE - -	1
RADNOR - -	1
Total - WALES -	15
Total - **ENGLAND AND WALES** -	162

ENGLAND AND WALES

A LIST
OF SOME OF THE
PRINCIPAL PARLIAMENTARY PAPERS
RELATING TO
ELECTORAL STATISTICS
SINCE THE PASSING OF THE REFORM ACT (2 W. 4. c. 45).

COMMONS.

Date.	Number.	Mover.	Title.
1833	189	Mr. Hume - -	A Return of the number of electors enrolled in the register in each county, division of county, city, borough, or place as entitled to vote under the 2 Will. 4. c. 65. at the last general election in Great Britain; distinguishing as far as possible the number of freemen and scot and lot voters in each city or borough, also the number of voters who have polled at each election. pp. 229.
1834	591		Report of the Select Committee appointed to inquire into the expenses charged by returning officers at the election of members for counties and boroughs in England and Wales, Scotland, and Ireland, at the last general election, and also to inquire into all other expenses attendant on the registration of votes and at the election, with the view of fixing one uniform rate of charge.
1838	329	Mr. Hume - -	A Return in alphabetical order from every county, city, and borough in England and Wales, of the number of electors registered in each, for 1836 and 1837; classifying them under their respective qualifications: Of the number of electors who actually polled in every county, city, and borough of England and Wales, at the late general election; classifying them under their respective qualifications: Of the number of freemen in each city and borough in England and Wales on the register of 1837 as entitled to vote in the election of Members to serve in Parliament; specifying the number of such freemen who are not entitled to vote by virtue of any other qualification for Members of Parliament: And of the total number of municipal electors on the register in each city and borough returning a Member to serve in Parliament in England and Wales, after the revision of 1837; stating the number of such electors who are not also qualified to vote for Members to serve in Parliament, and of those who are so qualified as freemen only. pp. 306.
1847	751	Mr. William Williams	Return for the year 1846 of the number of electors on the registers of each county, city, town, and borough in England, Wales, and Scotland returning members to Parliament; exhibiting the several qualifications, and distinguishing those who are required from those who are not required to pay rates and taxes to entitle them to be placed on the registers. Tabular Return of the several qualifications of electors in the counties, cities, towns, and boroughs of England, Wales, and Scotland which returned members to Parliament previous to the passing of the Reform Act; distinguishing the qualifications for which the payment of rates and taxes was required from those for which such payment was not required. pp. 28.

Date.	Number.	Mover.	Title.
1849	630	Mr. Poulett Scrope -	A return from the several parishes or townships in the counties of Lancashire, Suffolk, Hampshire, and Gloucestershire respectively of the number of tenements assessed to the rate for the relief of the poor, made next before the rate now collecting; specifying the amount of such rate, the number of assessments rated under 4*l.* annual value, at 4*l.* and under 5*l.*, at 5*l.* and under 6*l.*, at 6*l.* and under 8*l.*, at 8*l.* and under 10*l.*, at 10*l.* and under 12*l.*, at 12*l.* and under 15*l.*, at 15*l.* and under 20*l.*, at 20*l.* and above respectively. Also the number of tenements assessed at each of these several values of which the occupiers have been excused (so far as the same can be ascertained). pp. 53.
1852	2	Mr. Poulett Scrope -	Returns from the several parishes and townships in England and Wales of the number of separate assessments in the rate for the relief of the poor made next before the rate now collecting, specifying the amount of such rate, the number of assessments, the annual rateable value of which is under 1*l.*, and at 1*l.* and under 2*l.*, at 2*l.* and under 3*l.*, at 3*l.* and under 4*l.*, at 4*l.* and under 5*l.*, at 5*l.* and under 6*l.*, at 6*l.* and under 7*l.* at 7*l.* and under 8*l.*, at 8*l.* and under 9*l.*, at 9*l.* and under 10*l.*, and at 10*l.* and above 10*l.* respectively; together with the gross number of persons assessed in such rate: Of the number of tenements or premises assessed at each of these several values, of which the owners have been assessed instead of the occupiers, under the Act 13 & 14 Vict. c. 99., or any other General or Local Act: And the number of municipal electors on the burgess list last made out before the date of this order, in the several boroughs in England and Wales which return Members to Parliament and have a municipal corporation. pp. 362.
„	18	Mr. Bouverie -	A return of the numbers of the population and houses, according to the census of 1851, in the counties and divisions of counties, and in the cities, boroughs, and towns returning members to Parliament in Great Britain. pp. 15.
„	48	Lord John Russell, Sir George Grey, and Sir Charles Wood (Chancellor of the Exchequer).	A Bill to extend the right of voting for members of Parliament, and to amend the law relating to the representation of the people in Parliament.
„	86	Sir Charles Wood -	Return of the boroughs in Schedule B. of the Parliamentary Representation Bill, and of towns proposed to be added to such boroughs, specifying the population and the towns in which such parishes are situated, together with the number of separate assessments to the poor rate of 5*l.* and upwards in the parishes containing such boroughs and towns. pp. 86.
„	441	Mr. Hume - -	A return of the population and number of houses, according to the census of 1851, in every county and division of a county, and in all cities and boroughs returning members to Parliament in Great Britain respectively, with the number of members returned, also in towns containing upwards of 2,000 inhabitants not returning members to Parliament; such counties and divisions of counties, cities and boroughs, and towns respectively, to be arranged in separate tables, according to their population, and number of houses in each such town. pp. 25.
„	539	Mr. Locke King -	A return showing the amount of property assessed to the relief of the poor in each county and division of a county and in each of the boroughs and cities returning members to Parliament in England and Wales, for the year ending on the 25th day of March 1850. pp. 155.
1853	106	Mr. Hume - -	Returns showing the population and number of inhabited houses, according to the census of 1851, of counties, parliamentary divisions of counties, cities, and boroughs in England and Wales; distinguishing the separate population and number of inhabited houses in each, with the total of each county and parliamentary division of a county, including cities and boroughs, and the number of representatives returned to Parliament; also, as regards cities and boroughs, the number of houses rated to the relief of the poor, the number of houses and occupancies valued at 10*l.* rent and upwards, and the number of 10*l.* householders and occupiers on the register of electors; also, the gross number of electors on the register of each county, or parliamentary division of a county, city, and borough, according to the registration of 1851–52: And showing the number of electors polled at the general election of 1852, in continuation of Parliamentary paper, No. 591. pp. 11.

Date.	Number.	Mover.	Title.
1853	863	Sir FitzRoy Kelly -	Return of the number of electors registered at the last registration in the cities and boroughs of England and Wales, distinguishing—1. The number of persons having a right to vote as freeman or members of the old corporation ; 2. The number of persons having a right to vote as 10*l.* householders ; and 3. The number of persons having a right to vote in both capacities. pp. 3.
1854	17	Lord John Russell and Sir James Graham.	A Bill further to amend the laws relating to the Representation of the people in England and Wales.
„	69	Lord John Russell -	Returns of the population and number of houses, according to the census of 1851 (exclusive of represented towns), and also of the number of registered electors, in every county and parliamentary division of a county in England and Wales, at the last registration of 1853–4 (arranged according to population): 2. Of the population and number of houses, according to the census of 1851 ; also of the number of registered electors in cities and boroughs returning members to Parliament at the last registration of 1853–4 (arranged according to population): Of the number of electors in each city and borough in England and Wales, registered at the last registration of 1853–4 ; distinguishing the number under each qualification: 3. Of the number of municipal electors on the burgess list in each municipal borough in England and Wales, for the year 1863–4 ; specifying the instances where the parliamentary and municipal boundaries do or do not coincide: 4. Of the population of the hundreds of Lonsdale, Amounderness, and Blackburn ; also of the hundreds of West Derby and Leyland ; also of the hundred of Salford (exclusive of represented towns) in the county of Lancaster: accompanied by a sketch map of the above divisions : 5. Of the population of the Wapentakes of Staincliffe and Ewecross, Claro, Skyrack, and Morley, also of the Wapentakes of Barkston Ash, Osgoldcross, Strafforth and Tickhill, Staincross and Agbrigg (exclusive of represented towns), in the west riding of the county of York ; accompanied by a sketch map of the said divisions : 6. Of the population and number of houses, according to the census of 1851, and of the number of registered electors, of the cities and boroughs returning members to Parliament (exclusive of metropolitan boroughs) which have a population above 100,000 (to be arranged according to population) : and 7. The same of cities and boroughs returning one member only, and which have a population above 50,000 : 8. Of the population and number of houses, according to the census of 1851, of the parishes of Chelsea and Kensington : 9. Of the population and number of houses, according to the census of 1851, of all unrepresented towns containing a population of 20,000 and upwards (arranged according to population) : 10. Of the number of persons rated to the poor at the sum of 10*l.* and upwards, in each county of England and Wales, exclusive of represented towns; distinguishing, as far as possible, the number who are householders : 11. And of the number of persons rated to the poor at sums exceeding 6*l.* in every city and borough returning members to Parliament; distinguishing the number of those who are already on the list of parliamentary electors. pp. 21.
„	280	Lord John Russell	A Return of the number of the electors in each county and parliamentary division of a county in England and Wales, registered at the last registration of 1853–4 ; distinguishing the number under each qualification. pp. 3.
„	508	Mr. Newdegate	A Return of the number of persons rated to the poor at 50*l.*, 40*l.*, 30*l.*, 20*l.*, 10*l.* and upwards respectively, in each county or division of county, exclusive of the represented cities and towns in England and Wales ; distinguishing the number who are householders. pp. 3.

Date.	Number.	Mover.	Title.
1857	4 Sess. 2.	Mr. Locke King -	A Return of the number of electors in every county and division of of a county in Great Britain, according to the register of electors for 1850, 1851, 1852, 1853, 1854, 1855, and 1856, and as they appear in the register of electors for 1856 and 1857; distinguishing the different qualifications under which they are registered in 1856 and 1857, with the population of each county and division of a county, according to the census of 1851: And of the names of all cities and boroughs in Great Britain; showing the number of electors on the register of 1856 and 1857, and the population of each city and borough, according to the census of 1851. pp. 25.
"	317 Sess. 2.	Mr. Disraeli -	Returns of the annual value of all real property rated under Schedule (A.) of the income tax, for the year ended the 5th day of April 1857, in each county or parliamentary division of a county in the United Kingdom, exclusive of the real property in each parliamentary borough comprised within each such county or division: Of the annual value of all real property, rated under Schedule (A.) of the income-tax, for the year ended the 5th day of April 1857, in each parliamentary borough in each such county: Of the population of each county or parliamentary division of a county, from the Census of 1851, not including the population within any parliamentary borough in such county: And of the population of each parliamentary borough within each county. pp. 7.
"	337 Sess. 2.	Mr. William Williams	A Return of the number of electors in each of the metropolitan boroughs, and city of Westminster, on the register of 1856, and the number of all houses rated to the relief of the poor, stating the number in each parish of the said boroughs and city, and the population thereof at the last Census. pp. 3.
1858	63	Mr. Locke King -	A Return of the following information in respect of each parish, or part of parish, in England and Wales, not within the limits of any city or parliamentary borough, for the year ended Lady-day 1856, viz.:—1. Name; 2. Population (census 1851); 3. Gross estimated rental of the property assessed to the poor rate; 4. Rateable value; 5. Number of persons rated at 10*l.* and under 50*l.*; 50*l.* and upwards; 6. Number of electors on the parliamentary register.
"	290	Lord Stanley - -	Returns from the several parishes or townships in the counties of Lancashire, Suffolk, Hampshire, and Gloucestershire respectively, of the number of tenements assessed to the rate for the relief of the poor made next before the rate now collecting; specifying the amount of such rate, the number of assessments rated under 4*l.* annual value, at 4*l.* and under 5*l.*, at 5*l.* and under 6*l.*, and 6*l.* and under 8*l.*, at 8*l.* and under 10*l.*, at 10*l.* and under 12*l.*, at 12*l.* and under 15*l.*, at 15*l.* and under 20*l.*, at 20*l.* and above respectively: Of the number of tenements assessed at each of these several values of which the occupiers have been excused (so far as the same can be ascertained), and of the number of compositions with owners of small tenements. pp. 54.
1859	3	Sir Stafford Northcote	An amended Return in continuation of No. 317 (1857), showing the annual value of all real property, including railways and canals, rated under Schedule (A.) for the year ending the 5th of April 1857, in each county or parliamentary borough in the United Kingdom; the population according to the census of 1851; the number of parliamentary voters; the number of Members of Parliament; and the amount payable for the year ending the 5th day of April 1857 under Schedule (A.) in each. pp. 12.
	7	Mr. Benjamin Smith	A Return for the year 1857, showing, in columns, the number of houses, shops, warehouses, and other buildings in each borough in the United Kingdom of the yearly rent or value of 10*l.* and upwards; the number of parliamentary voters in each; the number of Members of Parliament returned by each; the number of houses, shops, warehouses, and other buildings of the yearly rent or value of 5*l.* and under 10*l.*; the number at 4*l.* and under 5*l.*; the number at 3*l.* and under 4*l.*; and the number under 3*l.*; also, the number of houses, shops, warehouses, and other buildings in each borough charged with poor rates, and the number not so charged; together with the population of each borough, according to the Census of 1851. pp. 8.

Date.	Number.	Mover.	Title.
1859	49	The Chancellor of the Exchequer (Mr. Disraeli), Lord Stanley, and General Peel.	A Bill to amend the laws relating to the representation of the people in England and Wales, and to facilitate the registration and voting of electors.
„	112	Mr. Knight - -	Summary of Return, No. 63, 1858, showing, in regard to each head of information, separate totals for each county division, and for each county; together with a total for the entire district returned, &c. pp. 2.
„	118	Mr. Tite - -	A Return " (prepared from the most recent particulars readily accessible, and restricted to a county summary,) of the number of persons in each county and division of a county in England and Wales assessed to the poor rate in respect of property of the annual rateable value of 1*l.* and under 2*l.*, 2*l.* and under 3*l.*, 3*l.* and under 4*l.*, 4*l.* and under 5*l.*, 5*l.* and under 6*l.*, 6*l.* and under 7*l.* 7*l.* and under 8*l.*, 8*l.* and under 9*l.*, 9*l.* and under 10*l.*, 10*l.* and under 11*l.*, 11*l.* and under 12*l.*, 12*l.* and under 13*l.*, 13*l.* and under 14*l.*, 14*l.* and under 15*l.*, 15*l.* and under 20*l.*, 20*l.* and under 25*l.*, 25*l.* and under 30*l.*, 30*l.* and under 40*l*, 40*l.* and under 50*l.* 50*l.* and upwards, respectively; together with the gross number of persons assessed to such rate in each county or division of a county, and of the number of separate tenements or holdings in the above-mentioned rate in respect of which the owners are rated instead of the occupiers under the Small Tenements Act, or any other General or Local Act, of the several rateable values above mentioned." pp. 2.
„	121	Mr. Bright - -	A Return of the annual value of all real property rated under Schedule A., for the year ended 5th April 1857, in each county or parliamentary borough in Great Britain; the population of each county and division of a county, and of each borough, according to the Census of 1841, and the computed probable population on 23rd (31st) March 1859. Also the number of parliamentary voters in each; the number of members of Parliament returned by each; &c. pp. 10.
„	123	Mr. Bright - -	A return showing the amount of property and income tax, under Schedules (A.), (B.), (D.), and (E.), charged in each borough within the United Kingdom, and in each county and division of a county, separately from the boroughs within the same; and also the total amount under the said schedules in each case, for the year ending 5th April 1857; &c. pp. 12.
„	140	Mr. Western - -	Return of the number of electors in every county, division of a county, city, and borough in Great Britain, according to the register of electors now in force. pp. 5.
„	141	Mr. Blackburn -	Return of the names of all constituencies in England and Scotland, classified as follows:—1. Having not more than 300 electors; 2. More than 300, but not more than 1,000 electors, and returning one member only; 3. More than 300, but not more than 5,000 electors, and returning one member only; 6. More than 3,000, but not more than 5,000 electors, and returning more than one member; 7. More than 5,000 electors, and returning less than three members; 8. More than 5,000 electors, and returning more than two members; with columns showing the annual value of the real property rated under Schedule (A.), the population by the Census of 1851, number of voters, and number of representatives for each constituency. pp. 11.
„	153	Mr. Byng - -	A return of the population and number of houses, according to the census of 1851, in each of the places named in Schedule I. in the Representation of the People Bill, and in the parishes of Chelsea, Kensington, and Hammersmith respectively: Of the number of persons rated to the poor at 10*l.* and upwards: And of the number of persons rated to the poor at 6*l.* and upwards in each of the places named in Schedule I. in the Representation of the People Bill, and in the parishes of Chelsea, Kensington, and Hammersmith respectively. p. 1.
„	171	Mr. Tite - -	Return of persons rated to the relief of the poor in the several represented cities and boroughs in England and Wales, together with the population, and the present number of registered electors in each city and borough. pp. 15.
„	255	Mr. Packe - -	Return of the names of the parishes in England where an order has been made by the vestry to put in force the Act 13 & 14 Vic. c. 99, for the better assessing and collecting the poor rates and highway rates in respect of small tenements. pp. 36.

Date.	Number.	Mover.	Title.
1859	251	Sir George Lewis -	A Return of the population and number of inhabited houses, according to census 1851, of counties, parliamentary division of counties, cities, and boroughs in England and Wales, Scotland, and Ireland; distinguishing the separate population and number of inhabited houses in each, with the total of each county and parliamentary division of a county, including cities and boroughs, and the number of representatives returned to Parliament; also, as regards cities and boroughs, the number of houses rated to relief of the poor in 1856, gross and net value of property assessed to relief of the poor in 1856, and number of electors on registers in 1857. pp. 19.
1860	—	Presented by command	A Return of male occupiers in parliamentary cities and boroughs. pp. 11.
„	5	Mr. Western - -	A Return (amended) of the number of electors in every county, division of a county, city, and borough in Great Britain and Ireland, according to the register of electors now in force. pp. 6.
„	57	Lord John Russell, Viscount Palmerston, the Chancellor of the Exchequer (Mr. Gladstone), and Sir George Lewis.	A Bill further to amend the laws relating to the representation of the people in England and Wales.
„	124	Mr. Villiers - -	A Return of the number of male persons resident within any parliamentary city or borough in England or Wales, or within seven miles thereof, who were assessed to the last poor rate made before the 7th day of November 1859, in any parish within such city or borough, as occupiers of tenements situate within such city or borough, at the gross estimated rental and rateable value respectively of 6*l.* and under 7*l.*; at 7*l.* and under 8*l.*; at 8*l.* and under 9*l.*; at 9*l.* and under 10*l.*; and at 10*l.* and over. pp. 33.
„	129	Mr. Clive - -	A Return of the number of electors in all cities and parliamentary boroughs in England and Wales in the years 1815, 1830, 1832–3, and 1859–60, with the total number in each year, and showing, for the two latter periods, the comparative increase or diminution, and the number of members; also, the qualification in each city and borough prior to the passing of the Reform Bill. pp. 5.
„	130	Mr. Clive - -	A Return for each parliamentary city and borough in England and Wales of the number of electors upon the register for the year 1859–60, together with the population of each, and the number of members, arranged according to population. pp. 6.
„	131	Mr. Clive - -	A Return for each county and division of a county in England and Wales, exclusive of the represented cities and boroughs; showing—1. The population, according to the census of 1851; 2. The gross estimated rental of the property assessed to the poor rate; 3. The rateable value (i.e. the net sum on which the rate was laid); 4. The number of persons rated at 10*l.* and under 50*l.*, and 50*l.* and upwards; 5. The number of electors on the parliamentary register, with the number of members returned. pp. 5.
„	132	Mr. Clive - -	A Return of the several parliamentary boroughs in England and Wales having a population of less than 7,000; showing the total number of electors in 1832–3 and 1859–60; the number of freemen, and the number of electors minus freemen; with the number of members returned by each; arranged according to population. pp. 2.
„	231	Mr. Bovill - -	A Return of the several parliamentary boroughs in England and Wales having a population of less than 12,000, according to the census of 1851; showing the total number of electors in 1832–3 and 1859–60, the number of freemen, and the number of electors minus freemen, with the number of members returned by each, arranged according to population. pp. 3.
„	238	Mr. Hunt - -	A Return of the number of persons rated as occupiers to the relief of the poor in 1853 in respect of property of the annual rateable value of 6*l.* and under 7*l.*, 7*l.* and under 8*l.*, 8*l.* and under 9*l.*, 9*l.* and under 10*l.*, 10*l.* and under 11*l.*, 11*l.* and under 12*l.*, 12*l.* and under 13*l.*, 13*l.* and under 14*l.*, 14*l.* and under 15*l.*, 15*l.* and under 20*l.*, 20*l.* and under 25*l.*, 25*l.* and under 30*l.*, 30*l.* and under 40*l.*, 40*l.* and under 50*l.*, 50*l.* and above, in every parish in England and Wales which contains a population, according to the last census, of not less than 5,000, and not situate within any parliamentary city or borough; and also the total of the same particulars as respects the remaining parishes in each county or division of county not included within any parliamentary city or borough. pp. 10.

Date.	Number.	Mover.	Title.
1860	256	Mr. Bentinck - -	A Return of the number of male persons resident within any parliamentary city or borough in England or Wales, or within seven miles thereof, who were assessed to the last poor rate made before the 7th day of November 1859 in any parish within such city or borough as occupiers of tenements within such city or borough at the gross estimated rental and rateable value respectively of 5*l.* and under 6*l.* pp. 6.
„	277	Lord Robert Montagu	Returns of the number of voters which appear on the parliamentary register for each county, city, and borough, in the United Kingdom for the year 1858; distinguishing the different classes of voters: And of the number of voters who recorded their votes for the several candidates at the last general election in each county, city, and borough in which the return was contested; with an abstract. (In continuation of Parliamentary Paper, No. 329, of Session 2, 1857.) pp. 17.
„	323	Mr. Ayrton - -	Return of the number of persons entitled to vote for knights of the shire, in respect of property situate in each city or borough containing a population exceeding 150,000; of the number of persons qualified to serve on juries; and of the total number of houses assessed to the house tax in each such city or borough. pp. 3.
„	332	Sir W. Miles -	A Return of the name of every parliamentary city or borough in England and Wales; the rateable value of such city or borough at Lady-day 1856; the gross estimated rental at Lady-day 1856; the annual value of property assessed under Schedule A., exclusive of railways and canals, for the year 1856–7; the annual value of property assessed under Schedule A., including railways and canals. The cities and boroughs to be placed in alphabetical order, and the total of each column to be given; the cities of London and Westminster, and the metropolitan boroughs of Marylebone, Finsbury, the Tower Hamlets, Lambeth, and Southwark, given separately. pp. 4.
„	558	Mr. John Locke -	A Return of the number of houses compounded for by landlords, of the annual value of 6*l.*, 7*l.*, 8*l.*, 9*l.*, and 10*l.*, and upwards, in each parish in the metropolitan boroughs; and the number of persons upon the Parliamentary Register, 1859 and 1860, in respect of the occupation of such houses. pp. 4.
„	559	Mr. Griffith - -	A Return of the number of houses compounded for by landlords, of the annual value of 6*l.*, 7*l.*, 8., 9*l.* 10*l.*, and upwards, in each of the cities and boroughs of England and Wales, except the metropolitan boroughs. pp. 5.
„	581	Sir W. Miles - -	An Abstract of the total number of persons included under each different rating, as specified in a Return, entitled Poor Rate Assessments (ordered to be printed, 23d April 1860), for the whole of the counties or divisions of counties in England and Wales, the ratings of the different parliamentary cities and boroughs being excluded. pp. 3.
1861	13	Mr. Villiers - -	Return of the following information in respect of each parish or part of parish in England and Wales, within the limits of any city or parliamentary borough, for the year ended at Lady-day 1856, viz.: 1. Name; 2. Population (Census 1851); 3. Gross estimated rental of the property assessed to the poor rate; 4. Rateable value; 5. Number of houses rated to the relief of the poor. pp. 38.
„	90	Mr. Macaulay - -	A Return of the total number of male persons in each parliamentary city and borough in England and Wales who were charged to any of the assessed taxes, or to the income tax, under Schedules (B.) and (D.) respectively for the year 1859-60; the number of such persons who were assessed to the poor's rate upon a gross rental of 20*l.* and upwards; 10*l.* and under 20*l.*; 6*l.* and under 10*l.*; and the number under 6*l.*; and how many were not occupiers of tenements rated to the poor. pp. 5.
1862	33	Mr. Bonham Carter -	Returns of the numbers of parishes in each parliamentary city and borough in England and Wales, and of the number and names of such parishes in each such city and borough in which the composition of poor rates, under any Local or General Act, or otherwise, exists, or has been adopted or allowed, specifying such Act and the limit of rateable value to which such composition applies. pp. 18.

Date.	Number.	Mover.	Title
1864	149	Mr. Locke King	Return of the number of electors, according to the registers of 1862 and 1863, in every county and division of a county, city, and borough, in England, Wales, and Scotland; showing also the total number of electors for the counties in England, Wales, and Scotland, and the like total for the cities and boroughs. pp. 7.
„	283	Mr. James White	Returns showing the population of each county or parliamentary division of a county in the united kingdom, exclusive of cities or boroughs, in the years 1821 (as far as possible), 1831, and 1861, with parallel columns showing the increase or decrease of each : 2. For cities and boroughs in each county returning members to parliament, showing the population in 1821 (as far as possible), 1831 (in continuation of Parliamentary Paper, No. 591, of Session 1834), and 1861, with the number of Members of Parliament returned by both counties and boroughs under the Reform Act, with parallel columns showing the increase or decrease of population since 1831: 3. Of the number of electors in 1832 (in continuation of Parliamentary Paper, No. 591, of Session 1834), and the number in 1862, in both boroughs and counties, with separate columns showing the increase or decrease both in boroughs and counties; distinguishing, as far as possible, the number of freemen, scot and lot voters, and potwallopers who were voters in 1832, and those who remain in in 1862. 4. Of the number of square miles contained in each borough before the Reform Act, and the present square miles of each borough (in continuation of Mr. Bright's Return) : 5. Of the annual amount of property and income tax levied under Schedules A, B, D, and E, in each county or parliamentary division of a county, and in each city or borough returning members to Parliament, in the year 1862 : 6. Of the parliamentary boroughs under 8,000 inhabitants in 1831 which still return members to Parliament, with the increase or decrease of population (1861) in parallel columns, with the number of members returned by each : 7. Of the boroughs which now exist returning members to parliament, having, in 1861, less than 8,000 population, stating, at the same time, the county in which each is situated, with number of Members of Parliament : 8. And of the municipal boroughs, the population of which, in 1861, exceeds 8,000, with all other towns of a like population which are either under the Health of Towns Act, or liable to be placed under it, and which return no members to Parliament, stating at the same time the county in which each is situated; the general totals added up and summarised. pp. 35.
1865	448	Mr. Blake	Return, in a tabular form, for the year 1864, of the number of electors on the register of each county in England and Wales, exhibiting the several qualifications. (In continuation of Parliamentary Paper, No. 751, of Session 1847.) pp. 5.
1866	81	Mr. Baines	Return of the number of male persons resident within each parliamentary borough in England and Wales, or within seven miles thereof, who are assessed in the valuation lists now in force, or, where there is no such list, in the last poor rate in any parish within such borough, at the gross estimated rental following ; viz., under 4*l.* ; of 4*l.* and under 5*l.* ; of 5*l.* and under 6*l.* ; of 6*l.* and under 7*l.* ; of 7*l.* and under 8*l.* ; of 8*l.* and under 9*l.* ; of 9*l.* and under 10*l.* ; 10*l.* and over : And of the population of each Parliamentary borough according to the Census of 1861 ; the gross estimated rental of the property therein according to the valuation lists now in force, or, where there is no such list, according to the last poor rate ; and the number of electors on the register now in force ; together with an estimate of the number of the electors in Parliamentary boroughs if the franchise were extended to male occupiers assessed at a gross estimated rental of 9*l.*, 8*l.*, 7*l.*, and 6*l.* (In continuation of a return of male occupiers in Parliamentary cities and boroughs presented, by command, in the Session of 1860.)

LORDS.

Date.	Number.	Mover.	Title.
1857	214	Lord Aveland	An Account of the number of county electors in each county, division of a county, or riding in England and Wales registered for property situated within the Limits of any borough; distinguishing the total number registered in each constituency, and also distinguishing the total number of county electors registered for property in each borough situated within the same.
1859	46	——	Report from the Select Committee appointed to inquire into the operation of the Act 13 & 14 Vict. c. 99, for the better assessing and collecting of the poor rates and highway rates in respect of small tenements, and of the Act of last Session, cap. 43, to amend the municipal franchise in certain cases.
„	45	Lord Monteagle	A Return of the number of electors in all cities and parliamentary boroughs in England and Wales in 1815, 1830, 1832–3, and 1859–60, showing for the two latter periods, the comparative increase and diminution and the number of the members; also, the qualification in each city and borough prior to the passing of the Reform Bill.
1860	46	Lord Monteagle	A Return for each parliamentary city and borough in England and Wales of the number of electors upon the register for the year 1859–60; distinguishing the number registered as 10*l.* householders, freemen, and scot and lot voters, or any ancient or reserved right, not being also registered as householders; together with the population of each, and the number of members; to be arranged according to population.
„	47	Lord Monteagle	A Return for each county and division of a county in England and Wales, exclusive of the represented cities and boroughs, showing—1. The population, according to the Census of 1851; 2. The gross estimated rental of the property assessed to the poor rate; 3. The rateable value (*i. e.*, the net sum on which the rate was laid); 4. The number of persons rated at 10*l.* and under 50*l.*, and upwards; 5. The number of electors on the parliamentary register, with the number of members returned.
„	48	Lord Monteagle	A Return of the several parliamentary boroughs in England and Wales having a population of less than 7,000; showing the total number of electors in 1832-3 and 1859–60, the number of freemen, and the number of electors minus freemen, with the number of members returned by each, arranged according to population.
„	53	Lord Monteagle	Return of the number of male persons resident within any parliamentary city or borough in England or Wales, or within seven miles thereof, who were assessed to the last poor rate made before the 7th day of November 1859, in any parish within such city or borough, as occupiers of tenements situate within such city or borough, at the gross estimated rental and rateable value respectively of 6*l.* and under 7*l.*, at 7*l.* and under 8*l.*, at 8*l.* and under 9*l.*, at 9*l.* and under 10*l.*, at 10*l.* and over.
„	87	——	Report on the probable increase of the number of electors in the counties and boroughs of England and Wales from a reduction of the franchise, and whether any or what change is likely to be made in the character of the constituencies by such increase.
„	126	Lord Llanover	Return of, 1st. The name of every parliamentary city or borough in England and Wales: 2d. The rateable value of such city or borough at Lady Day 1856: 3rd. The gross estimated rental at Lady Day 1856: 4th. The annual value of property assessed under Schedule A., exclusive of railways and canals, for the year 1856–7: 5th. The annual value of property assessed under Schedule A., including railways and canals: The cities and boroughs to be placed in alphabetical order, and the total of each column to be given: The cities of London and Westminster, and the metropolitan boroughs of Marylebone, Finsbury, the Tower Hamlets, Lambeth, and Southwark, to be given separately.

Date.	Number.	Mover.	Title.
1860	140	Lord Llanover	Return of, 1. The name of every parliamentary city and borough in England and Wales : 2. The number of Tenements rated to the relief of the poor at 8*l.* and under 9*l.*: 3. At 9*l.* and under 10*l.*: 4. At 10*l.* and upwards : 5. The total of columns 2, 3, and 4 : 6. The number of electors on the register : 7. The per-centage that the number of electors bears to the numbers given in column 5 : 8. The number of tenements rated as above at 4*l.* and under 5*l.* : 9. At 5*l.* and under 6*l.* : 10. At 6*l.* and under 7*l.* : 11. At 7*l.* and under 8*l.*: 12. The total of columns 8, 9, 10, and 11. : 13. The numbers that might be placed upon the register if the same per-centage is taken as shown in column 7 : 14. The numbers in columns 6 and 13 added.
„	145	Lord Stanley of Alderley.	Returns of the number of voters on the parliamentary register for each county, city, and borough in the United Kingdom for 1858 ; and of the number of voters for the several candidates in the last general and any subsequent election in each county, city, and borough, and the number of members returned.

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STANDARDS COMMISSION.

FIFTH REPORT

OF

THE COMMISSIONERS

APPOINTED TO INQUIRE INTO

THE CONDITION OF THE EXCHEQUER (NOW BOARD OF TRADE) STANDARDS.

ON THE

BUSINESS OF THE STANDARDS DEPARTMENT, AND THE CONDITION OF THE OFFICIAL STANDARDS AND APPARATUS.

Presented to both Houses of Parliament by Command of Her Majesty.

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CONTENTS OF REPORT.

Page

1. Reference to former Reports - - iii
2. Objects of this Report - - - - „
3. The Imperial standards of length and weight - - - - - - „
4. Parliamentary copies of the Imperial standards - - - - - „
5. Legal and official standards of weights and measures - - - - - iv
6. Imperial system: Standard weights - „
7. Standard measures of capacity - - „
8. Gas measuring standards - - - - v
9. Measures of length - - - - „
10. Total number of standards and legal denominations - - - - - „
11. Metric system: total number of ditto - vi
12. Question of legalising standards of 3½ and 1¾ lbs. as flour weights - - - - „
13. No weight or measure to be stamped or be legal of other denominations than the official standards - - - - „
14. Except multiples of 56 lbs. or 20 kilo. weights - - - - - - vii
15. And wooden and wicker measures of lime, &c. - - - - - - - „
16. As to glass and earthenware measures of capacity - - - - - „
17. Marking wine bottles with their legal denominations - - - - „
18. And marking of casks - - - - „

Page

19. Reverification of official standards, and verification of new standards - - viii
20. Accurate scientific methods adopted for the comparisons - - - - „
21. Details and results of these comparisons of Imperial standards - - - „
22. Construction of public standards of length ix
23. Legal allowance of error in official comparisons of standards - - - „
24. Verification of official standards of the Metric system - - - - - „
25. More uniform normal thermometric temperature and barometric pressure in comparisons of standards - - „
26. Metric standards presented by the French Government - - - - - x
27. Presentation to the French Government of complete set of Imperial standards - [illegible]
28. Meeting of International Standards Conference at Paris - - - - „
29. List of standards deposited in the Standards Department - - - - „
30. List of comparing and auxiliary apparatus of the Department - - - xi
31. Office accommodation - - - - „
32. Establishment of the Standards Departments - - - - - - „
33. Completion of business of the Commission „
34. Conclusion - - - - „

STANDARDS COMMISSION.

FIFTH REPORT.

TO THE QUEEN'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

IN obedience to Your Majesty's command contained in Your Majesty's Royal Warrant bearing date 4th May 1868, we, the Commissioners appointed to inquire into the condition of the Exchequer (now Board of Trade) Standards of weights and measures constructed under the provisions of the Act 5 Geo. 4. c. 74., and other Acts, and for other purposes set forth in the said Warrant, humbly offer to Your Majesty this our Fifth Report.

Reference to former Reports.

1. We may first briefly refer to our former Reports, relating to the following subjects:

In the First Report, which was of a preliminary character, we adverted to the progress of the reverification of the Official Standards, and the steps which were being taken under our sanction and directions for the improvement of the Standards Department.

Our Second Report bore more particularly upon the question of the introduction into this country of the Metric system of weights and measures, and embodied the results of our inquiries and deliberations in several practical recommendations, having for their object the permissive use of the Metric system in the United Kingdom, more especially for international transactions.

The abolition of Troy weight was the subject of our Third Report, in which we referred to such legislative provisions as appeared to us to be requisite in carrying out our recommendations for the simplification of the Imperial system of weight.

It was our endeavour to attain in our Fourth Report the more important object of the improvement of the existing system of verification and inspection of commercial weights and measures throughout the United Kingdom. With this view we have recommended considerable alterations in the law and practice of local inspection.

Objects of this Report.

2. We have now to lay before Your Majesty the final results of our labours during more than three years which have elapsed since our original appointment, on 9th May 1867. In this Report, we propose to refer more particularly to the establishment, duties, and instruments of the Standards Department, including also the number and denominations of legal weights and measures, the official standards of these weights and measures, and their verified accuracy, and generally as to the means by which the efficiency of the Department may, in our judgment, be best promoted and maintained.

The Imperial Standards of length and weight.

3. One of the principal duties of the chief of the Standards Department, imposed upon him by the Standards Act of 1866, 29 & 30 Vict. c. 82., is that of the custody of the Imperial standards of length and of weight, legalised by the Standards Act of 1855, 18 & 19 Vict. c. 72. These Imperial standards are kept in a fire-proof iron chest, and are deposited in a strong fire-proof room in the basement of the Standards Office, which has been specially fitted for the purpose. Every possible precaution is thus taken for their due security and preservation. At our meeting on 30th July 1870, we finally inspected these Imperial standards, and have satisfied ourselves as to their perfect condition.

Parliamentary copies of the Imperial Standards.

4. The four Parliamentary copies of the Imperial standards are deposited, in pursuance of the Standards Act of 1855,—

1. At the Royal Mint,
2. With the Royal Society of London,
3. At the Royal Observatory of Greenwich,
4. And (immured) in the New Palace at Westminster.

By s. 2 of the Standards Act of 1866, the Board of Trade are required, once in every ten years from the passing of the Act, to cause the three first-mentioned Parliamentary copies to be compared with the Imperial standards and with each other. This is a duty which will devolve upon the Warden of the Standards, under the provisions of the Act.

Legal and official standards of weights and measures. App. XVII.

5. A complete list of the number and denominations of all the secondary standards of weights and measures, both of the Imperial and of the Metric system, for regulating the weights and measures, which according to our opinion should be legalised for use in the United Kingdom, is appended to this Report. We shall presently advert to the standards of the Metric system, but may first briefly refer to those of the Imperial system.

Imperial system. Standard weights.

6. The existing number of Imperial standard weights is as follows:—

Avoirdupois weights, from 56 lbs. to the half dram, including also the weight of the standard gallon of water, and of a cubic foot of water - -	18
Troy weights per 5 Geo. 4. c. 74. - - - - - - -	15
Decimal bullion Troy weights - - - - - -	30
Total - - -	63

In our Third Report we have recommended the abolition of the Troy weights and decimal bullion weights, and the legalisation of a decimal series of avoirdupois grain weights, standards of which, 23 in number, have been constructed according to the following scale:—

4,000	2,000	1,000		grains.
500	300	200	100	„
50	30	20	10	„
5	3	2	1	„
0·5	0·3	0·2	0·1	„
0·05	0·03	0·02	0·01	„

In our Fourth Report we have recommended that standard weights of ⅓ and ⅔ ounce avoirdupois should be legalised specially for foreign postal services, as a temporary arrangement only, until the metric 10 gramme weight should be substituted for the ⅓ oz., as the unit for foreign postal services. These two standard weights have accordingly since been legalised by Your Majesty's Order in Council of 4th June 1870.

The standard coin weights of each coin of the realm, to be legalised under the provisions of the Coinage Act, 1870, 33 Vict. c. 10., are 20 in number, as contained in the first schedule of the Act. It has not appeared to us that any further number of standard coin weights, being multiples of the coin weights specified in the Act, and which are authorised in s. 17 to be made and legalised if required, are now actually needed.

The proposed future number of legal denominations of Imperial standard weights will thus be the same as that of the existing standard weights, viz.:—

Avoirdupois weights, including the weight of the standard gallon of water and of a cubic foot of water - -	18
Decimal grain avoirdupois weights - - - -	23
Standard weights of each coin of the realm - - -	20
Special foreign postal weights, being temporary standards -	2
Total - - -	63

Standard measures of capacity.

4th Report, App. IV., p. 234.
4th Report, App. VI., p. 281.

7. The standard Imperial measures of capacity, from the bushel to the half gill are now 10 in number, serving as measures both of liquids and of dry commodities. There is evidently a want of a smaller standard measure than the half gill, or half a quarter of a pint, as in many parts of the United Kingdom a quarter gill is commonly used and is stamped by many of the inspectors. In Ireland especially this small measure is much used, and is called a *half-glass*. We consequently consider it expedient to sanction a standard quarter gill measure, thus carrying the binary subdivision of this series of measures of capacity one step lower.

It has also appeared to us that the existing series of legal denominations of measures for liquids is quite insufficient for the public requirements. We have already recommended in our First Report that the following additions be made to the existing official standards, being five in number:—

Standards of ⅙ gallon and $\frac{1}{12}$ gallon, as measures of the wine bottle and half wine bottle; and standards of 4, 2, 1 fluid avoirdupois ounces, containing these weights of distilled water.

Standards of these measures have since been constructed for the Standards Department, and have been accurately verified. It has since been brought under our notice that liquid measures of grain weights of distilled water in a decimal series are much used throughout the kingdom for chemical and analytical purposes in which peculiar accuracy is required; but no standards of these measures exist, whilst they appear to be specially needed for obtaining proper and uniform precision in these liquid measures. We therefore recommend the legalisation of the following decimal series of such liquid measures of grain weights of distilled water, standards of which have been constructed and are deposited in the Standards Department, being 16 in number:—

7,000	4,000	2,000	1,000	grains.
500	300	200	100	„
50	30	20	10	„
5	3	2	1	„

We also recommend the following further standard measures of capacity—being cubic inch measures, seven in number—which are specially required for testing differences in comparisons of the larger measures of capacity, and have been procured for the Standards Department, to be legalised as standards:—

Cubic inch measures of 10, 5, 2, 1, 0·5, 0·2, 0·1 cubic inch.

Gas measuring standards. App. VIII.

8. Under the head of standard measures of capacity the gas measuring standards may be classed, being measures of gas or air, or standards of volume. It has been shown to us that whilst the standard gas measures of 5 and 10 cubic feet are sufficient for all comparisons of gas meters brought to be tested at the office of an inspector of gas meters, a further provision is required both for the original verification and subsequent reverification of large meters fixed in premises, and which cannot either be moved for verification to the inspector's office or be verified *in situ* by the existing standards. For such cases it appears to us both expedient and requisite that a standard test meter, passing five cubic feet of gas or air at one revolution, should be constructed and legalised as a standard, in order that copies may be duly verified for the use of the local inspectors or verifiers.

It has also been brought under our notice that the provision of the Sale of Gas Act, 1859, rendering it imperative, under penalties, that all gas meters which are fixed in any place throughout the United Kingdom should be duly stamped by an inspector, comes into operation after 10th October 1870, and that great facilities would be afforded for more effectually carrying out this provision by enabling gas meters so fixed to be verified by means of a more portable instrument than the existing gas measuring standards or the test meters constructed to pass five cubic feet at one revolution. For such purpose we are of opinion that a smaller test meter to pass one cubic foot of gas or air should be constructed and legalised as a standard.

Measures of length.

9. The only existing standard Imperial measure of length is the standard yard. In our First Report we stated our opinion that the following additional standards were desirable:—

"Standards of the chain of 22 yards divided into links, and of 100 feet divided into feet; of 10 feet, with decimal and duodenary subdivisions; of 2 feet and 1 foot, with other binary and other subdivisions of these measures, as well as of the yard."

We propose, in order more effectually to carry out this recommendation, that the following seven legal denominations of standard measures of imperial length be sanctioned, the requisite standards being either now constructed or being in process of construction:—

100 feet chain, divided into lengths of 10 feet each.
66 „ „ of 10 links each.
10 feet, divided into feet.
6 „ „
3 „ „ and nails or sixteenths; also into inches with decimal parts.
2 „ „ and inches.
1 „ into inches, and further decimal, duodenary, and binary subdivisions.

Total number of legal denominations of Imperial weights and measures.

10. The total number of legal denominations and standards of Imperial weights and measures proposed is as follows:—

Weights - - -	63
Measures of capacity -	45
Length - - -	7
	115

Metric system, Standards, &c.

11. The number and denominations of standards and legal weights and measures of the Metric system which we recommend for adoption, are those on the decimal scale generally accepted in the countries where the Metric system has been established, viz.:—

Weights -	23 -	Kilograms 20, 10, 5, 2, 1 or 1,000 grammes.	There is a duplicate unit in each decimal series to make up the number 9.
		Grammes 500, 200, 100 or hectogram.	
		„ 50, 20, 10 or dekagram.	
		„ 5, 2, 1, gramme.	
		„ 0·5, 0·2, 0·1 or decigram.	
		„ 0·05, 0·02, 0·01 or centigram.	
		„ 0·005, 0·002, 0·001 or milligram.	
Measures of capacity -	13 -	Litres, 100, or Hectolitre.	For dry commodities the demi-dekalitre is the smallest measure used.
		„ 50 „ Demi-hectolitre.	
		„ 20 „ Double dekalitre.	The litre is equal to a cubic decimetre or 1,000 cubic centimetres in volumes, or 1,000 grammes of distilled water at its maximum density.
		„ 10 „ Dekalitre.	
		„ 5 „ Demi-dekalitre.	
		„ 2 „ Double litre.	
		Litre, 1 „ Litre.	Demilitre = 500 cubic centimetres or grammes weight.
		„ 0·5 „ Demi-litre.	
		„ 0·2 „ Double decilitre.	Double decilitre = 200 „ „
		„ 0·1 „ Decilitre.	Decilitre = 100 „ „
		„ 0·05 „ Demi-decilitre.	Demi-decilitre = 50 „ „
		„ 0·02 „ Double centilitre.	Double centilitre = 20 „ „
		„ 0·01 „ Centilitre.	Centilitre = 10 „ „
„	3 -	5, 2, and 1 cubic centimetres or grammes weight of distilled water.	
Measures of length -	6 -	Chain of double dekametre or 20 metres, divided into—	dekametre or 10 metres. demi-dekametre or 5 „ double metre or 2 „ metre or 1 „
		Double metre.	
		Metre, divided into 10 decimetres.	
		Half metre „ 5 „	
		Double decimetre.	
		Decimetre, divided into centimetres, and one centimetre into millimetres.	
Total number	45		

Question of legalising standards of 3½ & 1¾ lbs. as flour weights. 4th Report, App. III., p. 142. App. IV., p. 234. App. VI., Nos. 4, 15, 27.

12. Several applications have been made to us to recommend the legalisation of standard weights of 3½ lbs. and 1¾ lbs. as flour weights. It appears that these weights of flour are constantly required for making loaves of bread of the weight of 4 lbs. and 2 lbs. respectively, more commonly known as quartern and half-quartern loaves, and that in fact iron weights weighing 3½ and 1¾ lbs. are much used in some districts and have been stamped by the local inspectors. But we have not considered it to be expedient that such weights should be allowed and standards legalised. If these weights were sanctioned, they would so nearly resemble the weights of the legal denominations of 4 lbs. and 2 lbs. that mistakes might frequently occur in their use, and facilities would certainly be given to fraud. The undue multiplication of standards and of legal denominations of weights is obviously to be avoided. It will also naturally occur that each of these two flour weights may be readily obtained by a combination of three smaller legal weights.

We may here remark in passing that the septenary scale of the larger weights of our avoirdupois system, as distinct from the binary scale of weights below 1 lb., was probably taken originally from the weight of 7 lbs. of flour being required to make the 8 lbs. or gallon loaf, and 14 lbs. of flour (or a stone, from using a stone as a weight) for making the 16 lbs. or peck loaf, flour having been the commodity for which weights were most frequently required to be used throughout the country in earlier times. Like our measures of length and capacity, as pointed out in our Second Report, our system of weights was thus originally based on the popular wants.

No weight, &c. to be stamped or be legal of other denomination than the official standards,

13. From the consideration of the number and denomination of legal standard weights and measures, we proceed to refer to their connexion with commercial weights and measures.

In our Fourth Report, we have amongst other things recommended that no weight or measure shall be stamped as legal unless it bears its legal denomination marked upon it. It appears that doubts have existed on the legal construction of the Weights and Measures Act 5 & 6 Will. 4. c. 63., as to whether an inspector is authorised or required to stamp as legal any weight or measure, (other than single weights above 56 lbs.), for which there is no specific official standard. - We deem it of importance that such doubts, and the consequent diversity of practice which has resulted, should no longer be allowed to exist; and that the law should expressly declare that no weight or measure, except as herein-after stated, should be stamped as legal, or be legal, being of other denomination than those of the before recited legal denominations for which official standards shall have been duly provided.

except multiples of 56 lbs. or 20 kilo. weights,

14. The following exceptions to this regulation may be allowed:—Single weights being any multiple of the 56 lb. or 20 kilo., the greatest of the Imperial and Metric Standard weights; such multiple weights should have their actual weights marked upon them, and be stamped by the local Verifier, who may compare each multiple weight with the like number of single standard weights.

and wooden and wicker measures of lime, &c.

15. Wooden or wicker measures used in the sale of lime or other articles of the like nature, may be specially excepted from being marked with a legal denomination of measure and from stamping and inspection, as they now are under s. 21 of the Act 5 & 6 Will. 4. c. 63.

As to glass and earthenware measures of capacity.

16. We consider that the existing provision in the above recited clause for excepting glass and earthenware measures of capacity from being stamped should be repealed. We are satisfied that there is no practical difficulty in impressing the stamp on a metallic stud to be affixed to the measure, or by other modes which can be specified in the official instructions to be issued to Verifiers. These glass and earthenware measures should also come under the general regulation of having their legal denomination of measure marked upon each of them. We may here also express our approval of the existing provision in s. 5. of the Weights and Measures Amending Act, 22 & 23 Vict. c. 56, authorising the stamping of graduated glass vessels, reference to which has been made in the Appendix to our Fourth Report.

4th Report, App. VI., p. 301.

Marking wine bottles with their legal denominations.

17. As we have recommended the legalisation of a standard bottle, and half bottle containing respectively $\frac{1}{6}$ and $\frac{1}{12}$ of a gallon, the question naturally arises whether the ordinary bottles of such capacity, commonly known as reputed quarts or pints, in which wine, ale, &c. is sold, should be marked with their denomination and be stamped.

4th Report, App. XII., p. 396.

In the Appendix to our Fourth Report, reference has been made to the former Prussian law which required all glass bottles made in inland glass houses to be marked with a stamp expressing the contents in legal measure, and to the hesitation of the Standards Commission of 1841 to recommend the adoption of such a regulation in this country, on account of the great depreciation to be caused in the value of the immense stock of wine bottles on hand. We may here observe that no such regulation is contained in the new weights and measures law of the North German Confederation, and that when the question was brought under the notice of the Committee of the Federal Parliament to whom the project of law was referred, they decided against the regulation on the ground that "difficulties would arise against carrying such a provision into execution, besides which "the public are quite able to take care of themselves in such matters."

2nd Report, App. II., p. 107.

Upon this point we are of opinion that the objection entertained by the Commission of 1841 still remains in force, and we concur with the German Committee in deeming it unadvisable to require the stamping of bottles in which wine and other liquors are sold, so as to denote or to certify their actual contents. There must always remain the difficulty of discriminating between wine bottles manufactured in this country, and those imported from foreign countries, to which any regulations made by our legislature for stamping bottles could not apply. The providing standards of measure of the standard wine bottles and other denominations appears to us to be an effectual means of enabling the public to ascertain in each case that they get their proper quantity of the commodity purchased.

To this may properly be added a regulation that in all sales of liquids in glass or earthenware bottles or vessels, declared to contain a specified legal measure, whenever this legal measure shall not be stamped upon the glass or earthenware bottle or vessel, an adhesive label shall be placed upon it by the seller specifying its contents of legal measure.

and marking of casks.

18. Some of the considerations which apply to the stamping of wine bottles, are also applicable to the question whether all casks used for the measurement of commodities bought and sold, should be duly stamped or marked with their contents of legal measure.

It is to be observed that Germany appears to be the only country in which it is required that casks should be so marked. There is no such regulation in France; nor does it appear that casks are stamped in the United States of America, although it may be worthy of notice that when the question was recently raised before a Committee appointed by the

4th Report, App. X., p. 331.

2nd Report, App. II., p. 106.

Government of the United States, they expressed their opinion that "all methods of "measuring or gauging the contents of casks were uncertain," and recommended that instead of gauging the quantity of spirits contained in casks, when required to be known, the actual quantity should be estimated by means of the weight; and for this purpose they drew up a table of the measures of capacity corresponding to different weights and strength of spirits. In Germany, the old law required that all casks should be marked with their legal contents under penalties, and this regulation is continued by the new law of the North German Confederation, although objections were raised against it in the Committee of the Federal Parliament on the ground that "the capacity of casks, espe-"cially after any repairs, was too variable to be subjected to compulsory verification, "and the stamp would tend rather to mislead the public, than protect them from fraud." It was only upon the expressed wish of wine growers and wine merchants, contained in petitions addressed to the Federal Parliament, that the Committee decided on retaining the regulation.

We have not had sufficient evidence before us to enable us to pronounce a decided opinion upon this question, and do not feel justified in making any recommendation for the compulsory stamping of casks. But it is a question that we think deserving of consideration by the Legislature. If deemed desirable, authority might be given by law to the Board of Trade, to make regulations for the stamping of casks with their capacity in legal measure, and their tare weight. At all events, it is obvious that, whether stamped or not, casks should not come under the restriction of being limited to measures for which there are specific official standards. It should be expressly allowed that they may contain any multiple of an authorised measure.

Reverification of official standards and verification of new standards.

19. Passing from the subject of the legal denominations of standards and commercial weights and measures, we have next to advert to their material representatives, the standard weights and measures of the Standards Department. We have been commanded "to ascertain how far these standards agree with the Imperial standards of "length and weight, and with each other, and to report to Your Majesty the result of "our enquiries," and also "to direct and superintend the steps necessary to be taken "until all the official standards are proved to be in perfect condition," and we now proceed to state how the duties thus imposed upon us have been discharged.

Accurate scientific methods adopted for the comparisons.

20. The actual comparisons of these standards have been made by the officers of the Standards Department, under the immediate direction and superintendence of the Warden of the Standards. They have been carried out with strict regard to the highest scientific accuracy, the elaborate processes adopted for the original verification of the Imperial standards having been followed in the departmental comparisons. These processes, so far as they relate to the original verification of the Imperial standard yard and standard pound, by the Committee for the restoration of these standards, are fully described in the memoirs drawn up by the Astronomer Royal and Professor Miller, contained in the Philosophical Transactions of the Royal Society for 1856 and 1857; and they have served as precedents for the reverification of the official standard measures of length, and standard weights, as well as for the original verification of the new standard measures of length and weight, which have been constructed under our sanction. The methods adopted at an earlier period for the original verification of the official standard weights and measures of length and of capacity under the Commission of 1824, and which were carried out under the immediate superintendence of Captain Kater, are described by him in the Philosophical Transactions of the Royal Society for 1826. The official standard measures of capacity have now been reverified in the same manner by weighing their contents of distilled water, and this method has also been pursued in the original verification of the new standard measures of capacity.

Details and results of these comparisons of Imperial Standards.

21. The fullest details of these comparisons and of their results have been described in a series of papers drawn up by the Warden of the Standards and laid before us in a printed form. These papers are now appended to this report. All the operations have thus been brought clearly under the cognizance of each member of the Commission, and we are consequently enabled to declare with confidence that the comparisons have been made in the most effectual manner, and that the results are entirely satisfactory, the actual weight or measure of each standard in its relation to the Imperial standards of weight and length having been ascertained with scientific accuracy.

With respect also to the gas measuring standards, these have been reverified by a process similar to that by which they were originally verified in 1860, under the immediate superintendence of the Astronomer Royal and Professor Miller, and with the like satisfactory results. The new standard test gas meters, to which we have already adverted as proper in our judgment to be constituted auxiliary standards to the gas measuring standards, are now in process of construction, and we are satisfied that their verification may be effectually made by the Warden of the Standards, and the results laid by the Board of Trade before Your Majesty, with a view of their being legalised by Order in Council, under the provision of the Standards Act, 1860.

Construction of public standards of length.

22. It may be proper to observe that the standard measures of the two Imperial chains of 100 feet and of 66 feet respectively, mentioned in s. 10, which it is proposed to lay down as public standards, are not yet constructed, although all the arrangements have been made by us for their construction as soon as an eligible site shall have been decided upon for them, where they may be used by the public under proper regulations. Official communications with the Office of Works are now in progress for this object, and they comprehend the laying down also a public standard of the Metric chain, as well as mural standards of other Imperial and Metric measures of length. The further steps necessary to be taken for the completion and verification of these public and mural standards may be left to the responsible government officers.

Legal allowance of error in comparisons of standards.

App. XVI.

23. We have already adverted in our First and Fourth Reports to the amount of error to be allowed in the comparison and verification in the Standards Department of copies of the official standards, upon which Your Majesty has commanded us to report our opinion, and we have recommended a provisional scale (subject to modification) which has been adopted; we have also recommended that power should be given by law to the Board of Trade to make regulations from time to time upon the amount of error to be tolerated. Meanwhile and until such power shall be granted by the Legislature, we have approved of a modified scale to be adopted, and made applicable to all the official standards of the Imperial system which are proposed to be constituted legal standards. This scale is given in an Appendix, and we now recommend this scale for Your Majesty's approval to be legalised by Order in Council, in pursuance of the provisions of s. 5 of the Standards Act, 29 & 30 Vict. c. 82.

Verification of official standards of the Metric system.

24. By processes similar to those adopted in the verification of the official standards of the Imperial system, a complete set of standards of the Metric system of length, weight, and capacity, has also been accurately verified in the Standards Department, and these are, according to our judgment, in every respect fit and proper standards for the comparison of Metric weights and measures. The primary standards upon which these verifications have been based are the two platinum standard metres of the Royal Society, originally constructed pursuant to a resolution of the House of Commons, in 1818, and at that time accurately verified with the original standard metre at Paris, these two standard metres having been lent to the Standards Department for this purpose; the platinum kilogram verified in 1844, by Professor Miller with the original standard kilogram at Paris; and a brass standard litre, accurately verified at Paris in the autumn of last year.

More uniform normal thermometric temperature and barometric pressure in comparisons of standards.

App. XV.

25. In connexion with the official comparisons of standards both of the Imperial and Metric systems, our attention has been called to the importance of establishing a more uniform normal thermometric temperature and barometric pressure in such comparisons as require scientific accuracy. A paper upon this subject is appended, which has been submitted for our consideration, and we have agreed to the following resolutions:—

Considering that with respect to all comparisons in air of Standard Imperial Weights and Measures in which scientific accuracy is needed, it is desirable to adopt, both in the Standards Department, and generally in this country, a more uniform normal temperature and barometric pressure, to which the several comparisons shall be reduced,—

> We are of opinion that whilst, in the case of primary standard weights, it is necessary to reduce all weighings to the weight in a vacuum, in all cases of weighing either Imperial or Metric weights in air, when the weighings are required to be reduced to air of a normal thermometric temperature and barometric pressure, the standard temperature of 62° F., and the standard barometric pressure of 30 inches, at or to be reduced to the temperature of 32° F., be adopted, and that all commercial weights be regulated accordingly.
>
> That whilst for the primary standard metre, the French standard temperature of 0° C., or 32° Fahr., be taken, at which temperature the official standard metre is laid down, all departmental comparisons with the official standard metre be made at ordinary temperatures of the air, in like manner as comparisons with the official Imperial standard measures of length, the standard temperature for all such comparisons being taken to be 62° Fahr.

That in all determinations of standard Imperial measures of capacity, either for dry goods, liquids, or gases, the above-mentioned standard temperature of 62° Fahr. and barometric pressure of 30 inches be adopted, and that this standard temperature be applicable to the temperature of the air, liquid, or gas, to be noted in such determinations.

That, in regard to metric measures of capacity, whilst the standard capacity of the primary standard measures of each denomination be determined with reference to the weight of water at its maximum density (generally taken at 4° C. or 39°·2 F.) contained in each standard measure respectively, all comparisons with these standards of local standards or commercial measures be made at ordinary temperatures, the standard ordinary temperature both of the air and of the water contained in such measures being taken to be 62° F.

That it is expedient that provision be made by law for the adoption of such normal temperature and barometric pressure.

Metric standards presented by the French Government.

26. The standard litre, to which reference has been made, is part of a series of Metric standards, for which a request was made by Your Majesty's Government to the French Government, in pursuance of the recommendation contained in our Second Report, that "metric standards, accurately verified in relation to the primary metric standards at Paris, "should be deposited in the Standards Department." This request was readily acceded to by the Imperial Government at Paris, and the Warden of the Standards was invited to assist in their verification at the Standards Department of France, the Conservatoire Imperial des Arts et Métiers.

These Metric standards are as follows:—

A brass standard mètre à traits.
A brass standard mètre à bouts.
A gilt brass cylindrical kilogram.
A gilt brass cylindrical kilogram with a knob.
A brass standard litre.

The necessary comparisons for completing the verification of these standards were in great part made last year, but some further observations are deemed requisite, which it is proposed should be made at the earliest period.

Together with the Metric standards thus specified, a complete series of the official standards of the Metric system, and of the standard apparatus used at the principal bureaux de vérification in France, have also been requested from the French Government, and are in course of preparation, for deposit in the Standards Department.

Presentation to the French Government of a complete set of Imperial Standards.

27. It having been ascertained by us that in the large and interesting collection of standards at the Conservatoire Imperial des Arts et Métiers in Paris, which are publicly exhibited, and include copies of the standards of many foreign countries, there are no specimens of our Imperial standards, except copies of the new standard yard and pound, presented in 1855, a recommendation was made by us to Your Majesty's Government that a complete set of our Imperial standard weights and measures should be constructed, and when accurately verified, should be presented to the French Government, for deposit in the Standards Collection at Paris. This recommendation having met with the concurrence of Your Majesty's Government, the necessary steps have been taken for the construction of these new standards, and they are now nearly ready for verification.

Meeting of International Standards Conference at Paris.

App. XIII.

28. We may here refer to the appointment of an International Conference at Paris, for the construction of new primary Metric standards, based on the existing Metric standards of the Archives, uniform primary copies of which, to be made and verified with all the latest appliances of modern science, are proposed to be furnished to every country in which the Metric system has been adopted, or its adoption contemplated. Some papers explanatory of this subject are appended. On the invitation of the French Government to send delegates from this country to the Conference, and on our recommendation, three of the members of this Commission, the Astronomer Royal, Professor Miller, and the Warden of the Standards, have been nominated by Your Majesty's Government to represent this country. The opening of the Conference has been fixed for 8th August next, and it has been officially announced by the French Government that the first meeting will be held on that day, notwithstanding the outbreak of war with Prussia.

List of Standards deposited in the

29. A complete list of the standards now deposited in the Standards Department, or to be deposited there, has been drawn up under our direction and is appended. The old standards of an antiquarian or historical character, and which are not now

required for official use, are distinguished from the serviceable standards. Amongst the latter class we may specify the kilogram of rock-crystal which has at our request been constructed at Munich for the Standards Department, and has been verified under the immediate superintendence of Dr. Von Steinheil. This is a copy of the rock-crystal kilogram constructed by him, which is of great repute as a scientific standard. A copy of his glass metre is also in process of construction and verification.

Standards Department. App. XVIII.

30. Under our sanction and directions, large and valuable additions have been or are being made to the comparing and auxiliary apparatus of the Standards Department. A complete list of this standard apparatus, including balances, thermometers, barometers, and other requisite instruments is appended, and we may report our opinion that the Department will now be completely supplied with all the necessary standard equipments "for conducting all such comparisons, verifications, and other operations with reference "to standards of length, weight, or capacity, in aid of scientific researches or otherwise," as is required by s. 11 of the Standards Act of 1866.

List of comparing and auxiliary apparatus of the Department. App. XIX.

31. The building in which the standards and apparatus are kept is well suited for the purpose, and has been specially fitted up for the reception and use of these valuable instruments. The old Jewel Tower has been added to the office accommodation, and is particularly adapted for standard operations from the great thickness of the stone walls which prevents fluctuation of temperature, as well as from its stability and comparative freedom from vibration; vaulted ceilings and iron doors and window shutters add to the security of the standards and apparatus kept in this fire-proof Tower.

Office accommodation.

32. The last part of the subject upon which we have to report relates to the establishment of the Standards Department.

Some preliminary information as to the officers of the Department and their duties was laid before us by the Warden of the Standards on our first assembling, and is now appended. The ordinary business of the Department up to that period is there described, but much additional work has been thrown upon the Department in the comparisons of Standards, and collection of the information, required by us for executing Your Majesty's commands. In the event of the several recommendations contained in our Reports being carried into effect, heavier and more responsible duties will be entailed on the Warden of the Standards and the departmental officers.

Establishment of Standards Department. App. I.

Up to the present time, the officers of the Standards Department, including the Warden of the Standards, have been appointed provisionally only, and it has been intimated to us by the Commissioners of Your Majesty's Treasury and by the Board of Trade that it was desirable that we should express an opinion what the staff and salaries of the Department should be. We have considered that our views upon this point should be stated separately in a Postscript to this Report, the Warden of the Standards, as being personally interested, abstaining from taking any part in our proceedings for this object.

33. We have before adverted to the mode in which the duties entrusted to us by Your Majesty have been executed, not only all the detailed processes of the comparisons and verifications of standards, but also the collecting and laying before us information relating to the existing system of inspection of weights and measures throughout the country and the operation of the weights and measures law, with suggestions for their improvement, having been undertaken by the Warden of the Standards, and his subordinate officers, and submitted to us for our consideration and judgment.

Completion of business of the Commission.

For this object, we have held thirty-one meetings during a period of more than three years, from 18th June 1867 to 3rd August 1870; and the progress of the work of the Commission thus carried on is fully recorded in our Minutes of Proceedings, which are now appended to this Report. A complete list of the Papers laid before us at these meetings is added to our Minutes of Proceedings.

Minutes of Proceedings appended, and list of Papers laid before the Commission.

34. In presenting our Fifth Report to Your Majesty we conclude our labours.

Conclusion.

For establishing and maintaining throughout the United Kingdom a really efficient system of weights and measures, based on standards verified with the highest scientific accuracy, two essential wants had long been felt, and these have been pressed from time to time upon the Government by every Commission and Committee who have inquired into the subject and made their reports.

The first of these wants was the establishment of a distinct department of Standard Weights and Measures, with a chief officer made responsible for the due discharge of all the requisite duties connected with these standards. This want has now been met by the establishment under Statute of the Standards Department of the Board of Trade.

The second want has been an authoritative control by such a responsible public department over the local officers of verification and inspection, with a view of enforcing a uniform system, in compliance with the provisions of an amended weights and measures law. The numerous applications made to the Warden of the Standards by local inspectors for information to guide them in the performance of their duties show also conclusively the need of a code of official regulations and instructions. In the recommendations contained in our several Reports, we have endeavoured to point out how these objects may most effectually be attained.

4th Report, App. VI.

All which we humbly submit to Your Majesty.

G. B. AIRY (Chairman).
COLCHESTER.
STEPHEN CAVE.
JOHN GEORGE SHAW LEFEVRE.
EDWARD SABINE.
W. H. MILLER.
H. W. CHISHOLM.

7, Old Palace Yard, Westminster,
3rd August 1870.

POSTSCRIPT ON THE SUBJECT OF THE ESTABLISHMENT OF THE STANDARDS DEPARTMENT.

The Commissioners of Your Majesty's Treasury and the Board of Trade having intimated to the Standards Commission that it should express its opinion as to the staff and salaries of the Standards Department, which the Commission have recommended to be constituted, the Commission have deemed it advisable that the Warden of the Standards, as being personally interested, should not take any part in our proceedings on this subject, and that the opinion of the other members of the Commission should be stated by way of Postscript to the Fifth Report of the Commission.

The duties which the department will have to perform afford the best foundation for any suggestions we may be able to offer; these are detailed in the Appendix I. to this Fifth Report; but it may be convenient to set them forth briefly as preliminary to our observations. They are as follows:—

The custody of the Imperial Standards of length and weight, of the official and secondary standards, of the trial pieces at the Mint of the gold and silver coin, the metric standards, and the gas measuring standards, and the various instruments, machinery, and articles requisite for comparisons and verifications.

The periodical comparison, verification, and reverification of the official standards, of the secondary standards, and of the local standards used by the verifiers, also of the standards for the colonies, and of weights and measures which public bodies or individuals require for scientific purposes, or which Her Majesty's Government may on behalf of Foreign Governments or otherwise desire to be compared or verified.

The recording in proper registers these various comparisons, verifications, and reverifications, and the issuing of certificates accordingly.

The preparation of the annual report of the department, and of the tabular information, including the collection and digesting of the annual returns from the local officers, which should be laid before the Board of Trade and Parliament.

The preparation and, under the Board of Trade, the issuing to the various local officers full instructions for the performance of their duties.

The correspondence with these officers and with the local authorities throughout the country, as well as with individuals requiring information upon the subject of weights and measures.

The periodical inspection of the local standards and apparatus by the verifiers of standards proposed in the Fourth Report of the Commission.

The inquiries necessary to enable the Board of Trade to judge of the propriety of the appointments and dismissals of verifiers and inspectors, and generally the bringing under the notice of the Board of Trade all improvements, scientific and practical, which may be made or suggested in the actual operations of the department, or otherwise, at home or abroad, with respect to the construction or verification of weights and measures, and all questions involved in home legislation, directly or indirectly affecting this subject.

The mere statement of these various functions appears to us to be sufficient to show that the Standards Department must be kept separate from the various other departments under the Board of Trade, and that, subject to the superintendence of the Board of Trade, it should be administered by the Warden of the Standards. As regards the status and emoluments and qualifications of that officer, we think it clear that the Warden must possess not only the ordinary official qualifications for superintending an important department, and for ensuring the safe custody and careful use of many valuable instruments, but also considerable knowledge, theoretical and practical, both in physical and mathematical science. He must likewise be able to give safe and intelligent counsel on many points of detail, including those of legal character, involved in the questions asked of him by magistrates, verifiers, and inspectors throughout the country, and by tradesmen who may believe themselves aggrieved by proceedings under the law relating to weights and measures. In some such cases of course the professional advice of the law officers of the Crown will be needed; but even in these the Warden of the Standards will have to draw up the case on which these officers are to report, so as clearly to bring out the points of difficulty. He will have also to organise, and take proper measures for accurately keeping up, the records of the various proceedings of verification.

All the business and correspondence of the Board of Trade on the subject of weights and measures will pass through the hands of the Warden, who must be prepared to call attention to the subjects which require it, and to give his best counsel thereupon.

Having regard to these duties and the qualifications requisite for their performance, we feel that the Warden of the Standards should not be placed on a lower footing than that of those gentlemen who superintend separate departments in the Board of Trade, as non-legal assistant secretaries; that in future his salary should commence at 800*l.* and rise to 1,000*l.* per annum. And having regard to Mr. Chisholm's age, and the number of years during which he has been in the public service, as well as the additional labour involved in the organisation of a new department, we recommend that in his case the maximum should commence at once.

Whatever may be the industry and zeal of the officer filling the position of the Warden of the Standards there must be occasions on which his absence will be inevitable, and an amount of vacation must be afforded to him sufficient to keep his mental and bodily health in a condition to perform his duties effectively.

We conceive, therefore, that there should be an officer in immediate subordination to the Warden, capable of carrying on his ordinary duties for a short period, and of disposing of the business of the office, with the exception of cases of a difficult and important character, which may ordinarily be delayed till the Warden is in attendance.

We are disposed to think that the status of this second officer, who must possess many of the necessary qualities of the Warden, though in a minor degree, should be that assigned to the first-class clerks in the Board of Trade.

It is difficult to state beforehand what further assistance the Warden and this second officer will require, as the number of verifications and the amount of correspondence cannot be estimated within any reasonable degree of accuracy. We desire, however, to observe that this assistance will not be merely of a clerical character, but will be used in the operations of verification. In reference to this point, we desire to notice that the prospects of promotion by any junior clerk in this limited departmental establishment will be very small; and the speciality of the duties in which they will have been engaged will give them small chance of becoming fit for advancement in the general office of the Board of Trade. We think that this matter should be borne in mind in determining both the minimum and maximum of their salaries, which might, we conceive, be certainly not less than those which would be assigned to junior clerks in an extensive Government office which presents large opportunities of promotion.

The premises which are now occupied by the Standards Department, and which, having been recently adapted for the purpose, are likely to remain so applied, contain instruments and articles of very considerable value, and require to be carefully looked after. This duty is at present performed, under the superintendence of the Warden of the Standards, by a person designated as office-keeper and mechanic, with a salary from 80*l.* to 100*l.* per annum, and with apartments in the premises, coals and candles. These additional advantages may probably be considered to bring his position sufficiently near that of other office-keepers. It must, however, be remembered that he must not only have the qualifications of trustworthiness and intelligence necessary for that post, but he must also be a clever workman and able to deal with delicate apparatus.

We think it probable that besides the office-keeper more than one messenger may be required, but this can only be decided on when the department is in activity, and in its normal condition.

In their Fourth Report the Commission has deemed it necessary to suggest the appointment of two or more inspectors of Standards, who should periodically visit the several districts of verification and inspection, and should inspect the standards, balances, and apparatus, and the office accommodation of each verifier, and the standards and other instruments of the local inspectors, and likewise gas meters, and should ascertain so far as possible that the provisions of the weights and measures laws and the official instructions of the Board of Trade for carrying those laws into effect have been duly complied with by the verifiers and inspectors.

We are sensible of the necessity of this visitation and superintendence, and we suggest that at first only two should be appointed, and that they should devote their whole time to their duties. We believe that the services of persons properly qualified might be obtained at salaries commencing at 300*l.* and rising gradually to 500*l.* per annum, with definite allowances for travelling and incidental expenses.

The withdrawal of our colleague, Mr. Chisholm, from the consideration of this particular subject of the establishment and salaries of the Standards Department affords us a welcome opportunity of expressing our sense of the amount and value of the assistance which that gentleman has rendered to this Commission during the three years of its existence.

The papers of information and suggestions which he has prepared and laid before us, and which have been appended to our several Reports, afford ample evidence of his merits in this respect.

He has been indefatigable in collecting from all possible quarters information likely to be useful to us from the manufacturers of weights and measures, from inspectors under the present system, and from tradesmen of high character and extensive experience. He has brought under our notice the measures which have been considered or adopted in foreign countries in relation to weights and measures, and in order to render this foreign information more accessible to the public has taken upon himself the labour of translating documents of great length and importance.

He has attended every meeting of the Commission, and has so arranged the business to be transacted as to involve the least possible demands on the time of his colleagues.

We willingly add that if the extensive change which we have recommended as to the inspection of weights and measures and the administration of the laws relating to them is to be carried into effect, it will be a source of gratification to us to feel that they may be superintended by a gentleman possessing the remarkable assiduity and care, the unusual fertility of suggestion, and the singleness of purpose which distinguish Mr. Chisholm.

G. B. AIRY (Chairman).
COLCHESTER.
STEPHEN CAVE.
JOHN GEORGE SHAW LEFEVRE.
EDWARD SABINE.
W. H. MILLER.

STANDARDS COMMISSION.

MINUTES OF PROCEEDINGS OF THE STANDARDS COMMISSION.

1st Meeting, 18 June 1867.

First Meeting. — Tuesday, 18th June 1867, at 2 p.m.

PRESENT:

The Astronomer Royal (Chairman).
The Earl of Rosse.
Lord Wrottesley.
Sir J. G. S. Lefevre, K.C.B.
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

The Secretary read the summons convening the meeting for 2.30 p.m. this day.

The Secretary read Her Majesty's Sign Manual Warrant, dated 9th May 1867, appointing the Commission. The Commissioners understood the Astronomer Royal to be Chairman of the Commission.

The Astronomer Royal read the Standards Act, 29 & 30 Vict. c. 82, and explained the position of the Warden of the Standards as defined by that Act.

The Commissioners present agreed that the "Commission" by which they are appointed is drawn up in the usual manner of *temporary* commissions.

The Astronomer Royal read letters from the Admiralty and to the India Department respecting the transfer of certain standards, the property of those departments, in the custody of the Astronomer Royal to the Standards Department. The Astronomer Royal also read a letter to the Treasury asking that certain standards and other apparatus in his custody, the property of the Treasury, be handed over to the custody of the Standards Commission. He also read a reply from the Treasury. The Commission desired the Warden of the Standards to see Mr. Hamilton upon the subject.

The Commission then took into consideration the two following propositions of the Astronomer Royal:—

1. It may be proper to consider the expediency of a recommendation to Her Majesty's Government on the reimbursement to the non-resident members of the Commission of their travelling expenses.

The Warden of the Standards undertook to speak to Mr. Hamilton respecting these expenses, in order that the usual course may be adopted.

The Commissioners then took into consideration—

2. Remarking that five papers of the most elaborate and important character have been communicated by the Warden of the Standards to the members of the Commission, it may be advantageous to come to a decision on the order in which the various subjects of those papers shall be considered.

The Commissioners decided that the papers be considered in the following order, II., V., I., IV., III.

The Warden of the Standards having inquired on the best authority for laying down the metre on the compared standard of length now in construction, it was decided that the best existing authorities appear to be the platinum metres of the Royal Society, and it was suggested by the President of the Royal Society that a letter be addressed by the Warden of the Standards to the Council of the Royal Society, requesting the loan of the platinum metres.

The time of the next meeting was left to the Chairman.

It was proposed by Lord Wrottesley, and agreed unanimously, that it is necessary that a messenger be appointed for the Commission, and that his services were required also for the Standards Department. It was left to the Warden of the Standards to speak to Mr. Hamilton also upon this point.

The meeting then closed at 4.30 p.m.

G. B. Airy,
Chairman.

2nd Meeting, 19 July 1867.

Second Meeting. — Friday, 19th July 1867, at 2 p.m.

PRESENT:

The Astronomer Royal (Chairman).
The Earl of Rosse.
The Master of the Mint.
Sir J. G. S. Lefevre, K.C.B.
The Warden of the Standards.

The minutes of proceedings at the last meeting of the Commission were read and confirmed.

The Chairman stated that he had been informed by the Warden of the Standards that it was customary to forward notice of the meetings of Royal Commissions to the principal London newspapers, and that he saw no objection to this course. Agreed to.

The Warden of the Standards was requested to explain the result of his interview with the Secretary to the Treasury.

Mr. Chisholm said that he was informed by Mr. Hamilton—

1. That the necessary authority would be given for the expenses, &c. of the Commission, including travelling expenses and the usual daily allowance for a Royal Commissioner.
2. That Mr. Hamilton concurred in the view that the Commission was appointed as a temporary Commission until the stated objects were attained, but that it might be then inexpedient to bring it to a final close, and that it might be revived for special occasions.
3. That he agreed also that the question of remuneration to the secretary might stand over until the business of the Commission should be finished, when any special recommendation of the Commission would receive due attention.
4. That the delay in giving the necessary directions for the expenses, &c. of the Commission had arisen from no decision having been come to upon the recommendation of the Board of Trade as to special remuneration to Mr. Chisholm for his services connected with the Commission.
5. That the recommendation of a temporary messenger for the Commission and Standards Department would be favourably received.

Mr. Chisholm added that no directions for the expenses of the Commission had yet been received, but that a temporary messenger had been appointed.

The absence of Lord Wrottesley, General Sabine, and Professor W. H. Miller was explained by the Chairman. It was understood that this meeting was merely a formal one for the transaction of the following business of which notice has been given.

The meeting then took into consideration the transfer of certain standards from the custody of the Astronomer Royal to that of the Standards Department. The Warden of the Standards read draft of the letter thereon proposed to be addressed to the Board of Trade. Agreed to.

Moved by Earl Rosse, seconded by the Master of the Mint, and agreed unanimously—

"That it appears to this Commission that the standards and apparatus connected therewith specified in the Astronomer Royal's letter to the Treasury of 30th May 1867, and proposed to be transferred from the Royal Observatory, Greenwich, to the custody of the Standards Commission, should be at once transferred from the custody of the Astronomer Royal to that of the Standards Department of the Board of Trade, and be placed under the immediate charge of the Warden of the Standards."

The meeting then considered the propriety of calling upon the local authorities to furnish returns relating to weights and measures. Draft of circular letter to local authorities and forms of returns agreed to.

Proposed by Sir J. G. S. Lefevre, seconded by the Warden of the Standards, and agreed unanimously—

"That the Secretary take the necessary steps for procuring the returns relating to standards and other weights and measures referred to at p. 54 of Paper III. laid before the Commission by the Warden of the Standards."

2ND MEETING, 19 July 1867.

The Warden of the Standards laid before the Commission a paper on the length of the metre in relation to the British Imperial Standard. To be printed and left for future consideration.

It was left to the Chairman to fix the day of the next meeting.

The meeting then closed at 4.15 p.m.

G. B. AIRY,
Chairman.

3RD MEETING, 1 Nov. 1867.

THIRD MEETING.—FRIDAY, 1st NOVEMBER 1867, at 11 a.m.

PRESENT:

The Astronomer Royal (Chairman).
The Master of the Mint.
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
Sir J. G. S. Lefevre, K.C.B.
The Warden of the Standards.

At 11.15 a.m. the minutes of proceedings at the second meeting of the Commission, on 19th July 1867, were read and confirmed. Before proceeding with the business of which notice had been given, the Chairman called attention to the great loss sustained by the Commission in the death of two distinguished members, Lord Wrottesley on the 27th ultimo and the Earl of Rosse on the 31st ultimo, as well as to the question of the expediency of strengthening the Commission by the addition of other members.

The President of the Royal Society agreed with Professor Miller in fearing that it would be hardly possible adequately to fill up the vacancies caused by the loss of the Earl of Rosse and Lord Wrottesley. All the members concurred in the opinion that an addition to their present number was very desirable, more especially since the aid of Sir John Herschel had also been lost to the Commission.

Sir J. G. S. Lefevre pointed out that, in event of additional members of the Commission being appointed, it might be desirable that at least one member of each House of Parliament should be selected.

The Warden of the Standards was requested to inform the President of the Board of Trade of the views of the Commission upon this subject.

In reply to the Chairman, the Warden of the Standards reported that the necessary authority for the expenses, &c. of the Commission, as requested by the Board of Trade, had not yet been given by the Treasury, and that he had again personally called the attention of the Treasury officers to the subject, and had been assured that it would be immediately attended to. He then read a letter from the Treasury to the Board of Trade, dated 26th September 1867, granting the Warden an addition of 200*l.* a year to his salary for his services on the Commission as a provisional arrangement, and stating that their Lordships anticipated the Commission would in their report recommend what should be the staff and salaries in the Standards Department.

1. The Astronomer Royal reported to the meeting that, under the authority of the Treasury letter of 26th July 1867, the standards and apparatus connected therewith then in his custody had on 2nd August 1867 been transferred to the Warden of the Standards, that the Admiralty and India Departments had approved of a similar transfer of their standards of length, and that Colonel Strange had been directed to hand over to the Warden the East India standard, which was now being cleaned by Messrs. Troughton and Simms.

The Commissioners agreed to the suggestion of the Warden that the numerous and valuable standards deposited in the Standards Department should (with the exception of the Imperial standard yard and pound kept in the strong room) be collected and arranged in glazed cases in the fireproof room in the Norman Tower, so as to be conveniently open to inspection; and the Warden was instructed to take the necessary steps for this purpose.

2. The Commissioners next took into consideration the correction of the ascertained errors in the official standards of avoidupois weight by the official minute of 15th October 1867, a printed copy of which was laid before each member of the Commission. The circumstances of the case having been explained by the Chairman, the Warden read his letter to the Astronomer Royal on this subject, dated 3rd October 1867, and the reply of the Astronomer Royal of the 5th October, together with the reference to the Board of Trade and their Lordships' approval.

3RD MEETING 1 Nov. 18

It was moved by Sir J. G. S. Lefevre, seconded by the President of the Royal Society, and agreed to,—

> "That this meeting approves of the course adopted, and entirely concurs in the opinion expressed by the Astronomer Royal in his letter of 5th October to the Warden of the Standards, 'that the Commission 'is bound to take as a principle that it is the business of a Standards Department to compare local 'standards, &c. with the *Imperial standards*, the 'official standards being considered only as intermediaries brought into use for the safety of the 'Imperial standards and for general convenience."

3. The Astronomer Royal stated that the Warden's paper, No. VI., had been printed and circulated amongst the members of the Commission, as well as Paper VII., which contained a translation of General Bäyer's report on the changes of length and expansibility of standard bars; and a further paper printed as a postscript to No. VI., being an abstract of Mr. Hassler's report to the American Congress relating to the length of the metre.

The Warden reported that, under the sanction of the Chairman, and in accordance with the expressed opinion of Lord Wrottesley, he had directed Messrs. Troughton and Simms to mark the length of the metre upon the new standard bar, as being equal to 39·37079 English inches, this being the only equivalent which could be officially recognised in the Standards Department, as having been formally reported to Parliament and generally accepted both in England and in France, and established by law in the Metric Act of 1864. The Warden also laid before the meeting a bound copy of several reports upon the American Standards of Weight and Measure. These papers, which had been printed for the Senate and Congress of the United States, had been sent with the American standards lately transferred to the Standards Department. They did not extend to a later period than 1842. He also produced a copy of the Act of Congress in 1866, "to authorize the "use of the Metric System of Weights and Measures" throughout the United States of America, containing a table of equivalents of customary weights and measures, and metric weights and measures, in which the metre is made equal to 39·37 inches; and the Warden suggested that it would be desirable that copies of other printed official papers relating to standard weights and measures in the United States, and in other foreign countries, should be furnished to the Standards Department. As further instances of the information contained in such papers, the Warden produced the procès-verbal of the French Standards Department, as to the verification of the primary metric standards for the Duchy of Modena in 1860, and of an official comparison in 1864 of the primary metric standards deposited severally at the Archives and at the Conservatoire at Paris, which had been sent to him by Mr. Yates.

The Commissioners concurred in this suggestion, and it was left to the Warden to communicate with the Astronomer Royal as to the best mode of carrying it out.

Professor Miller undertook to furnish to the Warden a list of scientific books and papers published abroad, copies of which should be furnished to the Standards Department.

4. The meeting next took into consideration the progress made in obtaining from the local inspectors returns relating to weights and measures.

The Warden reported that 1,172 printed forms of returns had been circulated to 431 places in Great Britain, and that up to the present time the returns had been received from 222 places, and were still coming in. In Ireland, where the inspectors of constabulary were *ex officio* inspectors of weights and measures, the inspector-general of constabulary had offered to undertake the transmission of the Irish returns, for which purpose 1,000 printed forms had been sent to him. A large number of these returns had been sent back containing the information required, and arranged for each county. All these returns were laid before the Commission by the Warden, together with printed forms of abstracts, which, when completed, would be exhibited to the Commission in a separate paper.

5. The Warden reported to the Commission some of the official communications made to the Department during the recess, and his replies thereto, relating to the execution of the duties of the local inspectors of weights and measures and other matters connected with the subjects referred to the Commission.

6. The Commissioners proceeded to consider the printed papers Nos. II. and V. furnished by the Warden of the Standards for their information. Paper No. II. appeared to be preliminary only, and intended to describe and illustrate the mode by which it was proposed to compare and verify the several official standards. Paper No. V. showed

3RD MEETING, 1 Nov. 1867.

the actual process and results of the comparison and verification of the official standards of avoirdupois weight, and the provisional comparison of the official troy standards. The Commissioners expressed their satisfaction with the mode adopted and that the exact errors of the several official standards of avoirdupois weight in relation to the Imperial standard had now been ascertained, the practical result being the correction of these standards, as shown by the resolution passed this day by the Commission. The accomplishment of this long needed object has thus been one of the first fruits of their labours.

In reply to the Master of the Mint, who observed that it was highly important that all the official standards should be verified as soon as possible, the Warden stated that the verification of the troy and bullion standards would be completed as soon as Professor Miller had confirmed and approved the comparisons and reductions of weighings of the platinum troy standard pound T and the gilt gun metal bullion standards of 10 oz. + 2 oz. The verification of the standards of capacity would be proceeded with as soon as the verification of the 10 lb. gilt gun metal standard had been also approved by Professor Miller, and the large balance had been completed and delivered for use by Messrs. Ladd and Oertling. The verification of the standard yard would be completed as soon as the new comparing apparatus with its improvements had been fixed by Messrs. Troughton and Simms, and the new subdivided standard yard had been also furnished by them.

7. The Register of Verifications of Local Standards and the Register of Comparisons of Standards were laid before the Commission.

Professor Miller pointed out the risk of damaging standard measures of length by stamping them, according to the present practice of the Department, and suggested that the official mark should be made upon them by a rapidly revolving drill invented by Mr. Grubb, of Dublin. The Commissioners agreed that the present practice of stamping standard weights and measures was objectionable, and might be advantageously improved, and the Astronomer Royal remarked that the Commission appointed to superintend the construction of the Imperial standards in their report of 1854 (s. 66, p. 17) had recommended the discontinuance of the existing practice of stamping standards. The subject was left for future consideration, and meanwhile the Warden of the Standards would communicate with Professor Miller upon it.

8. The Commissioners then inspected some of the standard weights and the several rooms of the Standards Department. The Warden showed that it was requisite that two more barometers should be furnished for the gas standards room and the comparing room in the Norman tower, and that additional thermometers were also required. The Commissioners agreed to this, and directed the Warden to take the necessary steps to procure them.

Professor Miller stated that the balance which had been used by him at Cambridge for verifying the standard weights might now be advantageously transferred to the Standards Department, and that he would first communicate with Ladd and Oertling in order to complete an arrangement made by him for changing the weights in the scales without opening the case.

Professor Miller also undertook to communicate with Messrs. Troughton and Simms respecting an instrument now in their possession, which had been constructed for and used by the Standards Committee, for ascertaining the densities of weights, with a view to its transfer to the Standards Department. This stereometer is described at page 799 of Professor Miller's report on the construction of the standard pound published in 1856.

It was left to the Chairman to fix the next day of meeting.

The Commission adjourned at 2.30 p.m.

G. B. AIRY, Chairman.

4TH MEETING, 9 June 1868.

FOURTH MEETING.—TUESDAY, 9th JUNE 1868, at 11 a.m.

PRESENT:

The Astronomer Royal (Chairman).
Lord Colchester.
The Right Hon. Stephen Cave, M.P.
Sir J. G. S. Lefevre, K.C.B.
The President of the Royal Society.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

The Secretary read Her Majesty's Warrant revoking the Commission of 9th May 1867 and appointing the new Commission of 4th May 1868.

4TH MEETING, 9 June 1868.

The Astronomer Royal was appointed Chairman of the Commission.

The Chairman stated the steps which lead to the reappointment of the Commission consequent upon the deaths of Lords Rosse and Wrottesley, the present Commission being in fact a continuation of the old Commission.

The Chairman stated the substance of the minutes of proceedings at the last meeting of the Commission on 1st Nov. 1867. These minutes were confirmed. It was agreed that the minutes of proceedings should be printed.

The Chairman called upon the Warden of the Standards to report progress since the last meeting, and to lay before the Commission any additional papers which he had prepared for the Commission.

The statement of the Warden was to the following effect:—

I.—*Subjects referred to at the last meeting of the Commission.*

1. All the Standards had been arranged in the Tower room, in the new glass cases, and were ready for the inspection of the Commission.

2. The supplementary weights to be used in correcting the errors of the official standards of avoirdupois weight were constructed by Mr. Oertling. (They were produced before the Commission.)

Sir J. Lefevre here called attention to the nomenclature of the several Standards. After some discussion it was agreed that,—

1. The two primary Standards of length and weight, the yard and pound, called the "Parliamentary Standards" in the report of the Commission of 1854, (the pound being marked P.S.,) should be called the *Imperial Standards*, being so termed in the Act of 1855, for legalizing the restored Standards, and in the Standards Act, 1866.
2. The four principal copies of the Imperial Standards, called *Parliamentary Copies*, both in the report of 1854, and in the Act of 1866, should continue to be so called.
3. The secondary Standards used in the Standards Department for the comparison and verification of local Standards, formerly known as the Exchequer Standards, and denominated the Board of Trade Standards in the Act of 1866, may most conveniently be called the *Official Standards*.
4. The Standard weights used for the comparison and reverification of the official standards, to be called the *Auxiliary Standards*.
5. The copies of the Official Standards used for comparing and verifying commercial weights and measures, to be called the *Local Standards*.

3. The subdivided yard and metre, and the improved microscopical comparing apparatus for measures of length, constructed by Messrs. Troughton and Simms, as recommended by the members of the late Standards Commission on 15th June 1866, and sanctioned by the Treasury 25th Oct. 1866, were completed and delivered at the Standards Department on 21st May 1868, and are now ready for use.

In connexion with the use of this comparing apparatus, the Astronomer Royal called attention to the satisfactory method originally suggested by himself to Mr. Sheepshanks (Airy's Report, p. 65,), and which was adopted, for comparing end measures with line measures by means of a defining line upon the end bars dividing the whole length into approximate halves. By placing two such end measures of a yard in a straight line, and end to end, a line measure of a yard is formed, which may be compared with a line standard. By applying this method to *three* end bars, the standard length of each may be found without difficulty.

4. The platinum line standard metre of the Royal Society, lent by them, and used by Messrs. Troughton and Simms for laying down the new metre, was also delivered to the Standards Departments on 21st May. The Warden stated that it would be desirable also to borrow the platinum end standard metre from the Royal Society, to complete the official comparison and verification of the new metre.

5. The American balance had been adjusted and fitted in a glass case by Mr. Oertling, and was now ready for use. It could be inspected by the Commission.

6. Additional barometers and thermometers had been provided for the use of the department.

7. A list of new papers and books relating to standard weights and measures was shown to the Commission.

With reference to the papers received from General Morin, and Herr Brix, Professor Miller thought it highly desirable

4TH MEETING, 9 June 1868.

that papers relating to the introduction of the metric system should be obtained also from Russia and Austria.

8. Barrow's balance, as well as several auxiliary standard weights, which had been used by Professor Miller, have been received from him.

9. The stereometer also used by Professor Miller appears, from inquiries made, to have been lost in transmission between Messrs. Troughton and Simms and Professor Miller.

It was agreed that a stereometer was most necessary for the use of the Standards Department.

II. *Papers prepared for the Commission by the Warden of the Standards.*

The following list of papers prepared by the Warden, or in preparation, was laid before the Commission.

LIST of PAPERS for the STANDARDS COMMISSION, by the WARDEN OF THE STANDARDS.

I. List of Standards; proposed additions, &c.

II. Proposed Mode of Comparison and Reverification of the Official Standards.

III. On the Business of the Standard Weights and Measures Department, and the Duties of its Officers; and the proposed Extension of the Powers and Business of the Department, particularly in relation to the Duties performed by the Local Inspectors of Weights and Measures.

III.—1. Addenda to Appendix G. of Paper III.

III.—2, &c. Further ditto.

IV. Preliminary Paper on the Allowance of Error in the Comparison and Verification of Standards; and the Question of an Allowance in the Comparison of Commercial Weights and Measures with Local Standards.

V. Actual Comparison and Reverification of the Official Standards of Avoirdupois and Troy Weight.

VI. The Length of the French Metre, and its relation to the Yard, the British Imperial Standard of Length; and P.S. to Paper VI.

VII. Translation of General Baeyer's Paper on Changes in Length and Co-efficients of Expansion of Standard Measures of Length.

VIII. Expenses connected with Verifications in the Standards Department of Local Standards of Weights and Measures, and generally as to the Local Verification of these Standards.

IX. On the Weights and Measures of Scotland and of Ireland.

X. Actual Comparison and Reverification of the Official Standard Bullion Weights, &c., based on Primary Platinum Standards; including the Principles and Practice of Comparisons of Standard Weights differing in their Densities.

X.—1, &c. Continuation of X.

XI. Copy of Memorandum on the Standards Commission, by the Warden of the Standards.

XII. Abstracts of Returns, A° 1866, from Local Inspectors of Weights and Measures, Great Britain.

XIII. Abstracts of Returns, A° 1866, from Local Inspectors of Weights and Measures, Ireland.

XIV. Summary of information relating to Inspection of Weights and Measures, &c.

XV. On the Law and Practice of the Metric System of Weights and Measures in France; the Construction, Verification, and Inspection of Metric Weights and Measures, and the Official Instructions relating to them; together with a Description of the Primary Metric Standards, the Metre and the Kilogram, and their principal Official Copies; and the Mode and Periods of their Reverification.

XVI. On the Metric System considered as an International System of Weights and Measures, and its proposed Introduction and Establishment in this Country.

XVII. On the question of the abolition of Troy Weight, &c.

XVIII. Actual Comparison and Reverification of the Official Standard Measures of Capacity.

XIX. Actual Comparison and Reverification of the Official Standard Yard, &c.

XX. Actual Comparison and Reverification of the Official Gas Measuring Standards.

XXI. On the Standard Weights and Measures of the United States of North America.

Of these Papers,—

No. I. to VII. inclusive had been previously delivered to the Commission,

Nos. III.—1., VIII., IX., X. in part, XI., XIII., and XV., were now formally delivered to the Commission.

No. III.—2., was nearly ready for distribution. The remaining numbers were not yet completed.

With reference to Paper IX. Mr. Chisholm explained that it was the duty of the Warden of the Standards to watch all legislation on standard weights and measures, and that he had prepared a memorandum upon a Bill now before Parliament to amend the weights and measures in Scotland, which he had forwarded to Mr. Cave. This memorandum was as follows:—

MEMORANDUM on BILL for amending Weights and Measures Acts (Scotland) proposed for second reading in Commons on 21st May 1868.

The Scotch acre is equal to 1·26118 English acre, or a little more than 1 English acre. It is based upon the old Scotch ell and chain. The ell=37·0958 English inches; the chain=24 ells. The English acre=4,840 square yards; the chain=22 yards.

The principle of this Bill is directly opposed to that of the existing weights and measures laws. Under sect. 15 of 5 Geo. 4. cap. 74, for ascertaining and establishing uniformity of weights and measures, all contracts for sale, &c. are to be made with the Imperial weights and measures, where no special agreement is made to the contrary; and in cases of special agreement with reference to local or customary weights and measures, the equivalent in Imperial weights and measures shall be expressed in such agreement, else it shall be null and void.

Under sect. 6 of 5 & 6 Wm. 4. cap. 63, local and customary measures are abolished, the Scotch ell being particularly specified.

It was shown in evidence before the Select Committee on Weights and Measures in 1862 (Qu. 229) that there were 25 different superficial measures of land then used in certain specified localities of the United Kingdom, the Scotch acre being one, all being other than Imperial measures. If this *bill* should become law the other 24 localities would have a just claim to have their local measures legalized, and the principle of *non-uniformity* of weights and measures would be established by law, as it now to some extent exists in practice though contrary to law.

Nor is this Bill in any way called for. The contract for the sale of growing crops, if made originally by the Scotch acre, can easily be stated by the English acre, by *merely adding one-fourth or thereabouts.*

Standards Department, H. W. CHISHOLM, Warden.
20th May 1868.

He had also forwarded a copy of this Memorandum to the Astronomer Royal, who stated in reply:—

> "Clearly you are right, not only as to the words of the law, but also as to the spirit of the law. At the same time, the continued existence of customs, not recognized by the law, but maintained in daily vigour by a large part of the population, makes one almost doubt of the soundness of the foundation of the law. When an agreement is made between man and man, in good faith, and in a verifiable form, ought the Legislature to assume the power of pronouncing it untenable? I am not quite sure."

With reference to Paper X., in part, the Warden called the attention of the Commissioners to the new duties thrown upon the department by sect. 11 of the Standards Act of 1866, of conducting all such comparisons, verifications, or other operations with reference to standards of length, weight, and capacity, as should be required in aid of scientific researches. This clause had been introduced into the Bill, when passing through the House of Lords, by Lord Wrottesley, his object being, as he stated, to make the department useful for the purposes of science. In No. X. the Warden had accordingly endeavoured to record the principles and practices of scientific weighings, both for the information of the Commission as to the course to be adopted in the department, and for the guidance of the officers in the practical operations. And he pointed out the necessity of carrying out these principles in the reverification of the official standards, as shown in Paper No. X., and alluded to the numerous failures and discordances in the comparisons, until the officers of the department had gained sufficient experience by practice, and the necessary alterations and improvements were made in the balances.

He drew attention also to the satisfactory results of the comparisons now made between the two platinum troy pounds T and R S, and the remarkably close approximation of these results to those of Professor Miller in 1845, proving that no appreciable variation in the relative weight of these two standard weights had occurred in the period of 23 years.

He produced also a MS. continuation of No. X., containing an account of the reverification of the weight of T and the other auxiliary platinum standard weights, by comparing them with P S, the Imperial standard pound. It had been found necessary for this reverification, to remove the Imperial standard pound from its place of deposit in the strong room, its removal and replacement being recorded in special minutes. The result of 125 weighings of T and the auxiliary weights with the imperial standard, and of 324 weighings of T and the auxiliary weights with each other, appeared to demonstrate conclusively that the absolute weight, not only of T but also of P S, was unaltered since 1845.

The continuation of No. X. contains also an account of the reverification of the two bullion standards of 10 oz. and 2 oz., these two standards having formed the base of the reverification of the troy standard weights, as stated in Paper V., as well as the final determination of the weight of the troy standards and their relation to the Imperial standard. This continuation will very shortly be printed and distributed to the members of the Commission.

Professor Miller deemed it to be of the highest importance that so satisfactory a result of the actual and relative weight of the platinum standards R S and T, and of P S, had been arrived at by the Warden, the more particularly as in consequence of the bad casing of P S, discovered in 1864, there was a chance of its weight having altered. The Commission concurred in this opinion.

The object of Paper XI. was a temporary one, to show the progress made by the Commission, and the expediency of strengthening it by appointing new members. It recites also the more important points in relation to the improvement of the system of inspection of weights and measures, to which the attention of the Commission may properly be directed.

In referring to Paper XII., now in preparation, the Warden stated the course taken to procure the completion of all the returns from the local inspectors, and read his second circular, of 19th March 1868, sent out for that purpose. Nearly all the returns had now been sent in. These returns were produced before the Commission, together with the abstracts, so far as they could be made up. He drew attention to the unsatisfactory return from the county of Hants, and read an accompanying letter from Captain Forrest, the chief constable. The Commission concurred in the suggestion that a further application should be made in this case to the Chairman of the Board of Magistrates for the County.

He also mentioned the anomalies now existing in the appointment and duties of inspectors in several places, particularly in metropolitan parishes, in consequence of the powers contained in Local Acts of Parliament.

And he pointed out the great amount of labour and attention required in the examination of the numerous returns, from both Great Britain and Ireland, and in preparing the several abstracts.

In producing Paper XIII. the Warden called the especial attention of the Commission to the fact that no fees for stamping weights and measures were now collected in Ireland, although the law in this respect was the same in Ireland as in Great Britain, and that it was the uniform practice in Great Britain to collect the fees chargeable by law.

With reference to Paper XV. and to the Bill now before the House of Commons for establishing the metric system in this country (a copy of which had been sent by him to each member of the Commission), the Warden said that he had sent a memorandum to the Board of Trade, of which the following is a copy:—

COPY of MEMORANDUM given to Mr. Cave on 24th February 1868, on which day Mr. Ewart, according to notice, was to bring in a Bill for introducing the metric system into this country.

THE METRIC SYSTEM.

One of the points referred to the Standards Commission is to inquire and report whether any and what additions to the existing official standards of weights and measures are now required, and it is understood that under this head is involved the expression of their opinion as to the establishment or continued prohibition of the metric system in this country.

With the view of placing before the Commission the fullest information upon the whole subject of the metric system in France, the mode in which it was established, and its practical working at the present time, the Warden of the Standards has been in communication with the head of the French Department of Weights and Measures, and has received from him copies of the laws, ordinances, and official instructions relating to the metric system, which will enable him officially to lay the requisite information before the Commission for their consideration.

Such information has not hitherto been afforded in this country, and it will enable the Commission not only to form a better opinion as to the actual working of the metric system in France, but to contrast it with the working of the Imperial system in this country from the information also being laid before the Commission in the detailed returns which they have called for from the several inspectors of weights and measures in the different localities throughout the United Kingdom.

It is suggested, therefore, that until such information shall have been laid also before the Government and Parliament, together with the report of the Standards Commission, any legislation to authorize the introduction of the metric system in this country will be premature.

Standards Department, H. W. CHISHOLM, Warden.
21 Feb. 1868.

He had also mentioned to Mr. Cave that, so far as he could estimate from the returns for 1866 from the local inspectors, there were probably not less than from 15 to 20 millions of Imperial weights and measures now in use in the country. Upon the second reading of the Bill in the House of Commons on 14th May, Mr. Cave, on the part of the Government, stated, in accordance with the memorandum, that they would not oppose the second reading, on the understanding that no further proceeding should be taken with the Bill until the Standards Commission had made their report, and he added that it was scarcely necessary for him to say that the report would not be made during the present session. This understanding was agreed to by Mr. Ewart, who moved the second reading of the Bill. A division was, however, insisted on by its opponents, and it was read a second time by a majority of 217 against 65.

[Mr. Cave then left, to attend a morning sitting of the House of Commons.]

III.—*Other matters arisen since last meeting.*

1. The Warden referred to the circumstances under which some of the standards in his charge had been sent, under the sanction of the Board of Trade, to the Paris Exhibition of 1867, at the request of the Executive Commission, who, acting through the Lord President of the Council, became responsible for their return at the close of the Exhibition, as stated in a letter to the Board of Trade, dated 20th March 1867, from Mr. Norman Macleod, the assistant secretary to the Commission.

Amongst the standards sent were the 1 lb. avoirdupois, No. 1, and 1 lb. troy, both of brass, being standards of a primary character constructed by Captain Kater, and mentioned at page 3 of Paper I. They were in perfect preservation, having been but once compared since they left Captain Kater's hands. These two standards were in separate boxes of heart of oak mounted in silver, and strict injunctions were given to Mr. W. G. Groser, the storekeeper of the department at South Kensington, who was authorized to receive them, that they should not be removed from their cases.

The standards were all returned to this department on 30th December last; some of the mahogany boxes containing the other standards being much injured, no care having evidently been bestowed upon them. The two standard weights before mentioned were brought in by the carter in his hand, bruised and battered, and appearing as if they had been rolling about the cart without the slightest protection, even of being wrapped in paper. The oak cases were not sent, although their two keys, with the labels upon them, were returned.

The Warden lost no time in addressing a letter to "Mr. H. Cole, the Secretary of the Commission, and Executive Commisioner," by whom the standards were returned, calling attention to the scandalous treatment of these two standards, and their irretrievable ruin as standards, and requesting that the missing cases might be returned. A reply from "Mr. R. G. Wyld, Secretary to the Executive Commission," dated 20th January 1868 stated that the standards had been delivered in Paris to the Imperial Commission, who had specially charged an officer with their care and arrangement, and that inquiries had been made on the subject of the Imperial Commission. No further or more satisfactory explanation has since been received.

The two standards were produced to the Commission, who inspected them and found that they were most seriously damaged by heavy rubbing on the surface, and partial abrasion of the surface. All these circumstances were directed to be recorded in the minutes of the Commission.

2. The loan on 26th November last, under the sanction of the Board of Trade, of the Cape 10-foot standard, and of General Roy's 3-feet bar, to Sir Henry James, being delivered to him at Southampton by an officer of the Standards Department, was reported to the Commission, who agreed with the Warden that they would be quite free from danger of injury in the hands of Sir H. James and the Ordnance Survey Officers.

3. The receipt in the department of some faulty local standards, sent for reverification, but since condemned, was then mentioned. These standards had been retained for the inspection of the Commission, and a list of them was produced with their errors. Amongst them was a 4-lb. weight, 98 grains deficient, which had been used last year to adjust sub-standards in the co. Wexford, and a Winchester bushel belonging to the borough of Sandwich, a measure declared illegal in 1824, and being 1¾ pint less than the standard. The errors of all these faulty standards are recorded in the "Rejected Standards" book.

The Chairman considered it to be of great advantage that the errors of local standards should be known by the Commission.

4. The loan from Messrs. Nichol and Fowler of a French metric weighing machine (balance bascule), to carry 500 kilo. and now placed in the Tower room for inspection, was reported. The Commission were satisfied with the general merit of its construction, but did not consider it important for the objects of the Commission.

5. Reference was made to the recommendation of the Standards Commission in their report of 1854, s. 33, that copies of foreign standards be deposited in the Standards

4TH MEETING, 9 June 1868.

Department, and to the statement by Kelly (vol. 1, p. 135–140, and vol. 2, p. 220), of numerous specimens of foreign standards having been obtained in 1818 by Lord Castlereagh from the respective governments, and which appear to have been deposited at the Mint. The Warden of the Standards suggested the expediency of these foreign standards being placed under his charge. The Master of the Mint had heard nothing of them, and he was requested to make inquiries and report on these standards.

6. The Warden stated that an application was made by the Inclosure Commission on 3rd June 1867 to verify the standard foot used by the survey department of the Commission, to which he replied that no comparison could be made until the new comparing apparatus was completed. The apparatus being ready for use, the Warden has acquainted Colonel Leach that he is now enabled to verify the foot measure; and that although there is at present no *legal* standard of a foot, there is no practical difficulty, as he has in his charge several standard foot measures constructed under the superintendence of the late Commission. As however no foot measure has yet been verified in this department, he must first obtain the sanction of the Standards Commission for the verification. The Commission concurred in sanctioning the verification for a public department.

Professor Miller thought it very desirable that private persons should be able to obtain copies of the official standards. In Prussia anyone could obtain an official copy of the primary standard for about 9*l.*

The Chairman remarked that the question of official verifications of weights and measures for private persons would be considered on a future occasion; and the Warden concurred in Professor Miller's opinion, but added that an alteration in the existing law should then be made, so that a proper fee should be charged for such verification.

7. With reference to a set of new metric Standards made of brass, and fitted in mahogany boxes, offered by Messrs. Tylor, of Newgate Market, London, to the Standards Department for 50*l.*, being much less than cost price, and made and certified by Deleuil of Paris, the Commission resolved:—

> "That the Commission recommend the purchase of these metric weights and measures for the Standards Department."

8. The Commission also agreed in the proposal made by the Warden that he should communicate with General Morin of Paris, in order that a complete set of local metric Standards and apparatus, as supplied by the French Government to the local Bureaux and to the Vérificateurs, should be obtained for the Standards Department.

9. Mr. Chisholm referred to a proposal made by Messrs. Tylor to construct a new standard gallon measure, by the use of which much time could be saved to the officer whose duty it was to compare measures, and who would be enabled to note a difference of a grain in the weight of a measure of a gallon. It was unanimously agreed:—

> "That the Commission are disposed to recommend that a copy of the standard gallon measure designed by Messrs. Tylor, be procured for the Standards Department, but that they desire further information upon the subject."

10. The Warden stated that distilled water was frequently required in the Department for the comparison of measures of capacity, and was now procured from time to time at considerable expense. As it was desirable that the water should be freshly distilled when required to be used, he suggested that for the purposes of both economy and accuracy in the comparisons, it was expedient that a still of the proper size should be furnished to the Department. It was therefore resolved:—

> "That a still of such dimensions as the Warden of the Standards shall think fit be provided for the use of the Standards Department."

11. With reference to an offer from Messrs. Ladd & Oertling, of sale to the Department of eight 10-lb. weights which were used for constructing the standard bushel measure in 1824, and of a quart specific gravity bottle, with weights, &c., packed in a box, the Commission did not think they were required for the use of the Standards Department.

12. The Warden then brought under the consideration of the Commission the question of making a provisional allowance for errors in the comparison of local Standards. He explained that no definite allowance had yet been established, but that in practice errors were necessarily allowed, as few local Standards sent for verification were absolutely correct. In the case of weights, the error now allowed was dependent upon the sensibility of the balance used, as stated in Appendix B, Paper IV., and generally speaking it had been found absolutely necessary to pass copies of the standards as correct when there was no greater error than those stated in Mr. Chaney's proposed scale of remedies appended to Paper IV. In case of any greater error, the Standard was returned for re-adjustment, and during the present year the Warden had much facilitated the labours of the manufacturers by introducing the new system of stating to them in writing the precise error of every standard so returned. It would be convenient that the proposed scale of remedies should be provisionally adopted.

Professor Miller thought this course desirable, and if after a time the scale was found inconvenient, a new scale might be adopted. The Commission agreed to this provisional arrangement, and it was left to the Warden to communicate further upon the subject with the Astronomer Royal and Professor Miller.

IV.—*The Business of the Standards Department.*

The business of the Standards Department was then considered by the Commission. The Warden read the following statement, showing the increase of business during the last year:—

COMPARATIVE STATEMENT of the BUSINESS of the STANDARDS DEPARTMENT, 1864–1868.

—	Year ending 31st March				
	1864.	1865.	1866.	1867.	1868.
Number of Local Standards verified -	587	556	575	595	796
Do. do. reverified	1,191	896	1,137	1,348	2,168
Number of New Indentures issued -	16	12	15	17	38
" Old " endorsed	61	71	83	79	108
" Standards numbered -	*Nil*	*Nil*	1,712	1,943	2,964
" Registers and books kept -	6	6	11	13	15
" Letters received and answered.	87	95	60	161	383
" Letters from Local Officers, appointing London Agents.	Nil	Nil	98	96	160
" Requisitions received from London Agents.	77	83	98	96	160
Totals - -	2,025	1,719	3,789	4,348	6,792

Note.—The above is a statement of the *ordinary* business of the Standards Department, and it does not include the responsible work connected with the reverification of the official Standards, nor that relating to the Returns from the local inspectors of weights and measures and other business, now being carried out in the Standards Department under the directions of the Standards Commission.

As a convenience to the public and a check upon the work done by the officers of this Department, the errors of *rejected* Standards are now given to the makers or local agents, who send local Standards to this Department, for reverification. This proceeding, including the accurate determination and recording of such errors, has much increased the labour and responsibility of the officers of the Department.

The Warden referred to his Report to the Board of Trade of 10th Dec. 1867, upon the increased duties of the Department, particularly the mechanical work and the consequent temporary employment of an additional mechanic, acting also as messenger. In fact, not only was the ordinary business of the Department still much in arrear, but also very slow progress was made in the reverification of the official standards and the other work for the Commission. The appointment of an additional permanent clerk and a mechanic, to act also as messenger, was now urgently required; but he pointed out that the Treasury were of opinion that it was for the Standards Commission to recommend what addition should be made to the permanent staff of the Standards Department.

Sir J. Lefevre thought it was highly important the business of the Standards Commission should not be delayed, and, after some further discussion, the Commission agreed unanimously to the following resolution:—

> "The Commission recognize the great and probable further increase of the labour of the Standards Department, and request the favourable attention of the Treasury and Board of Trade to the Warden's application for an additional clerk and an additional mechanical assistant."

The Warden referred to the question of the renewal of the official avoirdupois brass standards, and to the fact that brass had been condemned by the Commission in their report of 1854 as an unfit material for standards. As the supplementary weights were now used for correcting the avoirdupois standards, as a temporary arrangement he suggested whether it would not be desirable for the Commission very soon to take into consideration the question of

4TH MEETING, 9 June 1868.

new avoirdupois standards, as the subject of the renewal of the standards opened a wide field for investigation as to the best material, shape, &c. for the standard weights, and their construction and verification would occupy a long time.

Professor Miller would recommend the weights being made with a small cavity to hold an adjusting weight, and in two parts to screw tightly together, so as not to be separated except by some unusual force, and for the purpose of adjustment. This subject was left for further consideration.

With reference to the future business of the Commission, the Astronomer Royal said it would be desirable to consider the papers prepared by the Warden of the Standards in regular order, and that he would consider the best plan for carrying this view out. The Warden remarked that, with regard to some of the subjects for consideration, it would be highly desirable to hear evidence, and that he was prepared to produce several witnesses before the Commission.

It was left to the Astronomer Royal to arrange for the next meeting of the Commission. Tuesday was fixed on as the most convenient day of the week, and to meet at 11 a.m.

The Commissioners (including the Astronomer Royal, Professor Miller, and Lord Colchester) inspected the new apparatus in the Tower, &c., and the meeting adjourned at 3 p.m.

G. B. Airy,
Chairman.

5TH MEETING, 23 June 1868.

Fifth Meeting, on Tuesday, 23rd June 1868, at 11 a.m.

PRESENT:

The Astronomer Royal (Chairman).
Lord Colchester.
Right Hon. S. Cave, M.P.
The President of the Royal Society.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

A letter from Sir J. S. Lefevre was read, stating that he was detained by public business in the House of Lords.

1. The Chairman explained the course he proposed to be adopted in future with respect to the minutes of proceedings. That the minutes of each meeting should not be read at the next meeting, but being printed and circulated in proof, any member could send a corrected proof or note of corrections to the Chairman, who would cause the necessary alteration to be made in the proof returned to the printers. If no such correction was sent by a member, it would be understood that he wished for no alteration.

2. A report was delivered by the Master of the Mint, relating to the foreign standard weights obtained by Lord Castlereagh from the several Governments, and deposited in 1818 at the Mint, where they now remain in a press constructed for them; together with a copy of a letter from the Council Office, dated 23d September 1818, with which these weights were transmitted to the Mint. They were described as "copies of the weights and measures used for weighing gold and silver, &c. in the several countries," the names of the several places (54 in number) being stated, and the expense of procuring the weights. They were obtained at the request of Dr. Kelly, in pursuance of a plan ordered by Government for comparing the weights, measures, and monies of all trading countries by official experiments on verified standards. Having been duly verified and transmitted to London by the several Consuls, the standard weights were compared at the Mint with the British troy weights, and the results were published in 1821 in Dr. Kelly's Universal Cambist, under the sanction of the Government.

The Chairman and other members were of opinion that these verified foreign standard weights should be deposited in the Standards Department. The Master of the Mint saw no objection to this course, and suggested that an official application should be made to the Mint, in order that the authority of the Treasury for the transfer should be obtained. In the meantime, the Master of the Mint was requested to cause a list of the weights to be made out for the information of the Commission.

3. The Warden was called upon by the Chairman to read the correspondence relating to the standards sent to the Paris Exhibition, and their return, including a statement of the injury done to the two standard pound weights. After some discussion he was desired by the Commission to call the further attention of the Executive Commission to his letter of 30th December last.

5TH MEETING, 23 June 1868.

4. The subject of the metric system, and its introduction into this country, was considered by the Commission, so far as the late proceedings on this subject in the House of Commons appeared to require it.

Mr. Cave explained the course taken by him, on the part of the Government, with respect to the Metric Bill, which agreed with the statement in the minutes of proceedings of the last meeting of the Commission; and the Astronomer Royal read the Times' report of Mr. Cave's speech on the second reading of the Bill, on 28th May 1868.

The question was proposed by the Chairman, and was discussed, whether the Commission was now in a position to make any report upon the metric system. The Chairman stated his opinion that until further information was laid before them, particularly as to the progress of the metric system, and its introduction into foreign countries, no report could be made by them.

Mr. Cave thought that as it had been publicly stated by him that the Commission was now, through the Warden, collecting information upon the subject from abroad, it would be premature at present to report upon it, the more especially as he had distinctly stated in the House that the Commission would not be able to make their report this session.

The President of the Royal Society was of opinion that it would not be expedient to consider the question until the fullest information was before them.

The Chairmain read the following extract from Sir J. S. Lefevre's letter upon the subject:—

> "I venture to think that until both Houses of Parliament have pronounced more decidedly than they have done on the proposed international system of weights, measures, and coins, the Commission had better not come to any conclusion on the subject."

Mr. Cave thought that the House of Commons had pronounced most decidedly in favour of the metric system. And the Chairman was clearly of opinion that the Commission was distinctly called upon to report upon it, quite independently of any resolution come to by the House of Commons.

It was brought under the notice of the Commission that the metric system was made compulsory in Spain, after 1st January 1869; and that a law had just been passed in the parliament of the North German Confederation, for the establishment of the metric system throughout the Confederation, after 1st January 1872.

The Commission agreed that they were not yet in a position to make any report upon this subject.

5. The Chairman then referred to the question of metric standards, as one arising out of the discussion upon the metric system, and read his memorandum on metric standards, which had been printed and laid before the Commission.

In reply to a question by Lord Colchester, as to the operation of the Metric Act of 1864, Professor Miller said that orders from abroad were frequently received by mechanical engineers, for the execution of which they required metric measures, compared with an authoritative standard.

The Master of the Mint stated that metric weights were used almost exclusively in chemistry; and that in one chemical publication, several different equivalent values in Imperial weight were assigned to the gram. He thought this difficulty might be avoided if an authoritative standard could be referred to; and he saw no objection to metric standards being deposited in the Standards Department and used for verifying metric weights and measures. He considered, indeed, a recommendation to that effect to be the plain duty of the Commission, or they would lose their reputation as a practical body; and that the stringent construction of the existing law against the verification and use of metric weights and measures was ridiculous.

The Chairman said that the legal equivalent in British Imperial weight of the metric gram was expressed in the Metric Act of 1864.

Mr. Cave mentioned that repeated complaints had been made in the House of Commons that the present Metric Act was unsatisfactory. He added, with reference to an international tonnage, he had just suggested at the Board of Trade that the tonnage should be stated upon a ship's register in Imperial and in Metric measures.

The Warden said he had received information from weight and measure makers that many metric weights and measures were now made and used in this country, and that he was prepared to produce evidence to this effect before the Commission.

5TH MEETING, 23 June 1868.

The Chairman observed that he had particularly noticed that amongst the many persons examined before the Weights and Measures Committee of 1862, no single tradesman or person actually using weights and measures was examined.

He suggested that the Commission should consider the practical question, whether any steps could now be taken for providing and using metric standards.

The Warden said there was no *practical* difficulty whatever in the introduction of metric standards amongst the official standards of the Department, and in verifying metric weights and measures. Steps had already been taken for providing metric standards. They had already two most accurate kilograms, verified by Professor Miller, and a subdivided metre, the verification of which was now being proceeded with. A full set of metric standards, including the several multiples and parts, were also now recommended to be purchased from Messrs Tylor, as well as a complete set of copies of local metric standards and apparatus to be procured from Paris.

To a certain extent, also, the law now empowered the necessary authority to be given to him to verify metric weights and measures, as s. 11 of the Standards Act enacts that he should undertake all such comparisons of weights and measures for scientific researches or otherwise as the Board of Trade should direct. There is, however, the *legal* difficulty, that under s. 21 of the Weights and Measures Act, 5 & 6 Will. 4. c. 63., all metric weights and measures are declared to be illegal, and any person using them is liable to have them seized by an inspector, and to conviction and forfeiture. That is the construction put upon the clause by the law officers of the Crown, whose opinion, together with the case upon which it was given, has been laid before the Commission.

Professor Miller thought that, for the present, the official verification of parts and multiples of the metric units was scarcely required; that the public would be satisfied with the means of ascertaining correctly the length of the metre and the weight of the kilogram, and that it would be sufficient for the Standards Department to verify the units, without undertaking the comparison of the subdivisions and multiples. In reply to the Astronomer Royal's memorandum, he considered that there would be no risk of confusing the metre with the yard; that the difference of length would be evident, and, besides, the new measure of the metre being longer than the yard, there could be no danger of any shopkeeper fraudulently substituting the metre for the yard in measuring any commodities.

The Master of the Mint said it was desirable that the Standards Department should at once proceed with the verification of metric weights and measures for scientific purposes; and he urged the necessity of verifying the gram and its multiples up to the kilogram. As to the question of verifying and using metric weights and measures for commercial purposes, that was the business of the inspectors of weights and measures, which was not the point before the Commission. He was of opinion that, under the existing law, the Standards Department could be provided with metric standards, and could verify metric weights and measures for scientific researches or otherwise.

Mr. Cave said everybody was agreed that a shopkeeper could not now legally use metric weights and measures, and if he did, he was liable to a penalty. The question was whether the Department should not verify metric weights and measures for scientific persons, or for persons who do not buy and sell by them. The whole of the case which was referred to the law officers was drawn up in reference to the use of metric weights and measures in shops, which were liable to the visits of the local inspectors, and had no bearing on the use of them by scientific or private persons. He was disposed to put the question to the law officers, whether an artizan, chemist, or scientific man would act illegally in using metric weights and measures in his workshop or other place where there were no dealings with the public? The inspectors had no power to enter any other place than where goods were bought or sold, or conveyed or carried, and the law of 1835 generally was applicable only to the business transactions of shopkeepers and others, and to the duties of the local inspectors.

The Warden observed that before anything could be practically done to verify metric weights and measures in the Department, there were several questions to be considered and determined. A proper and convenient apparatus, and less elaborate than the new microscopic apparatus, must be fixed upon and provided for comparing and verifying copies of the standard measures of length and commercial measures, both imperial and metric. There was also the question of verifying for private persons, as under the existing regulations none but copies of the imperial standards were verified, and for the local authorities and public departments only; this also involved the questions of whether any or what fees or stamp duty should be charged on such verification, and whether further legislation would not be required for this object. Under s. 9. of the Standards Act all fees and stamp duty on the verification of standards, and on the indenture of verification, were abolished. There was, therefore, now not only no legal authority for charging any official fee for verification, but such charge appeared *primâ facie* to be illegal. There might, however, be a doubt as to the legal construction of this clause, which was drawn up by Mr. Reilly, the Government draughtsman, and by the Warden of the Standards together, with the view of its being applicable to the existing practice of the Department, and without any reference to s. 11. imposing upon the Department the duty of conducting "all such comparisons, verifications, and "other operations with reference to standards of length, "weight, or capacity, in aid of scientific researches or "otherwise, as the Board of Trade from time to time "authorize or direct." This last clause was introduced subsequently by Lord Wrottesley when the Bill was passing through the House of Lords. The Warden suggested that it might be desirable to prepare a case and to obtain the opinion of the law officers, whether the Board of Trade was restrained by s. 9. of the Standards Act of 1866, from authorizing a fee or stamp duty to be charged on the comparison and verification in the Standards Department, and with the official standards, of any weight or measure for scientific or private persons, and whether they were empowered under the provisions of s. 11., or by the general powers conferred upon them by s. 1., to authorize such charge. The principle of charging a fee upon the comparison and verification of all weights and measures was embodied in the Act of 1835, to which a schedule of fees was appended, as well as in a local and personal Act having reference to weights and measures; and in many cases, the receipts from such fees exceeded the whole cost of the local inspection of weights and measures. For instance in the County of Middlesex, where the expense of inspection was the highest of all, the receipts in 1867 exceeded the expenditure by 93*l.*

5TH MEETING, 23 June 1868.

Professor Miller considered that there could be no doubt that a charge should be made for official comparisons and verifications for private persons, and that the tariff should bear some proportion to the accuracy of the verification. He referred to the practice in Prussia, where the Standard Department supplied a verified bar measure to any private person for about 9*l.*, being probably double the cost price.

The Chairman asked Mr. Cave if there would be any objection to the passing a short Act to authorize a proper fee to be charged.

Mr. Cave thought there would not, but he doubted whether there was not power under the existing law to charge a fee. He stated that there was a decided objection in the House of Commons against doing work in public departments for private individuals free of expense, and, as a rule, they were in favour of the public departments being self-supporting. He concurred in the Warden's suggestion of preparing a case for the opinion of the law officers, both as to charging a fee for officially verifying weights and measures, and as to the official verification of metric weights and measures, and their use otherwise than for buying, selling, and conveyance or carriage of goods.

The Warden was accordingly desired by the Commission to prepare such a case for transmission to the Board of Trade.

6. Mr. Cave stated that the Bill for amending Weights and Measures Acts, Scotland, had been withdrawn.

7. The Chairman stated that at their next meeting they might consider whether they should agree upon their First Report, as it was probable that they would not hold another meeting before the recess.

The Warden said there were several points upon which it was desirable for the Commission to express an opinion, including the verification of such of the bullion standards as formed the base of the verification of the remaining bullion standards, and of the troy standards, as well as the verification of the official standard 10-lb. weight, the base of the verification of the standard measures of capacity, and the reverification of the official standard yard. The several weighings and reductions of the standard weights would first be submitted for Professor Miller's approval. He had delayed the preparation of his annual report to the Board of Trade, to be laid before Parliament, under the provisions of the Standards Act, until these objects were completed. He hoped to have the necessary papers

5th Meeting, 23 June 1868.

ready for the Commission if they met on Friday fortnight, the 10th July.

That day was accordingly fixed on, at 11 a.m. for the next meeting.

The Commission adjourned at 1 p.m.

G. B. Airy,
Chairman.

6th Meeting, 0 July 1868.

Sixth Meeting.—Friday, 10th July 1868, at 11 a.m.

PRESENT:

The Astronomer Royal (Chairman).
Lord Colchester.
Right Hon. S. Cave, M.P.
Sir J. G. S. Lefevre, K.C.B.
The President of the Royal Society.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

Upon being called on by the Chairman, the Warden stated the course which had been adopted for printing in proof the minutes of proceedings and circulating them to each member for correction, as agreed upon at the last meeting.

The Chairman pointed out the several corrections actually made in the printed proofs; and the minutes of the fourth and fifth meetings, as corrected, were confirmed, a printed copy being signed by the Chairman.

The Chairman read a letter from the Treasury, in reply to an application from himself, stating the rates of subsistence-allowance for Royal Commissioners and for witnesses, as follows, viz.:—

To each Commissioner, for every night absent from home on the duties of the Commission, 1*l.*

Or if sitting room is required, 1*l.* 10*s.*

To each witness examined before the Commission, for every night absent from home:—

Of the higher class, 1*l.*

In other cases, with reference to their condition in life, 15*s.* or 12*s.* 6*d.*

The actual cost of travelling, in the case both of Commissioners and of witnesses, is also allowed.

The Master of the Mint laid before the Commission a list of foreign standard weights deposited in Her Majesty's Mint, and was requested on the part of the Commission to apply to the Treasury for the necessary authority to transfer these standards to the Standards Department, to be placed in the custody of the Warden of the Standards; the Commission adopting the principle that it is expedient to collect specimens of all foreign standards of weights and measures, as well as other standards and weights and measures, of an original character, or otherwise important, as connected with the construction of primary standards, and to deposit them in the Standards Department.

The Chairman in referring to the standard pounds injured whilst in the custody of the Executive Commission for the Paris Exhibition, 1867, thought it became the duty of the Commission to take some step to guard against the recurrence of such damage to standards of importance.

After some discussion, and with the view of strengthening the authority of the Warden, in whose custody the standards are placed, the following recommendation was proposed by Professor Miller and agreed to by the Commission:—

That no standard of original character, or otherwise important, be permitted to leave the Standards Office, except for the purpose of comparison with other standards by persons duly authorised to use them for the public service, and who will be responsible for their custody and care.

At the desire of the Chairman, the Warden stated that a case had been laid before the law officers of the Crown as to the legality of verifying metric weights and measures in the Department, such weights and measures being to be used otherwise than for the purposes of buying and selling goods, or of estimating for their conveyance or carriage; also as to the legality of charging a fee for the official comparison and verification of weights and measures not being standards.

No opinion of the law officers having yet been given, the further consideration of these subjects by the Commission was postponed.

The Chairman then brought under the notice of the Commission the question of recommending the construction and legalization of official standard gold coin weights.

6th Meeting, 10 July 1868.

The Master of the Mint explained that formerly a special officer of the Mint was appointed for the stamping of money weights of *legal current* weights, but now one of the senior clerks of the Mint performed that duty. He was of opinion that it would properly be transferred to the Standards Department.

The Warden of the Standards concurred in this opinion.

The Chairman referred to Mr. Chisholm's report of 1863 upon the Exchequer Standards (p. 13), as containing a full account of the verification at the Mint of money weights; and he recommended the addition to the number of legal secondary standards of a series of standard troy weights applicable to the existing gold coins, to be placed in the Standards Department and used in the same way as other official standards.

The Master of the Mint pointed out the expediency of these standards being of the minimum legal current weight of the coin, and after some discussion the Chairman thought that the Commission should determine whether they should recommend the adoption of standards of the minimum current weight of gold coins or the full weight; and he put the question accordingly.

For the minimum current weight,—

Lord Colchester.
Mr. Cave.
The Master of the Mint.

For the full weight,—

Sir J. G. S. Lefevre.
Professor Miller.
The Warden of the Standards.

Upon which the Chairman gave his casting vote for the full weight.

The Commission agreed to the recommendation that a series of standard weights of the sovereign, and half sovereign, and multiples of the sovereign, equal in weight to the full legal weight of the gold coinage, be constructed and legalized and be deposited in the Standards Department.

Professor Miller suggested that standards of the minimum legal current weight of a sovereign and of a half sovereign be also recommended to be constructed and legalized; and this recommendation was also adopted.

The Chairman referred to the question of establishing a standard weight of 3½ lbs., as meeting the wants of the public, who required this weight for flour, oatmeal, salt, &c., a large number of these weights being now actually in use, and application having been made both to the Standards Commission and to the Standards Department to allow standards for 3½ lb. weights standards to be officially verified.

The Warden read letters on the subject from the inspector at Ashford, transmitted by Lord Romney to the President of the Board of Trade, and a similar application from the bench of magistrates at Kent (printed in the Warden's Paper III.).

After some discussion on the legality of aliquot parts of standard weights and of weights of other denomination than the official standards, the Master of the Mint pointed out that the present system of weights seem to be founded upon the *stone* as unit instead of the *pound*. The Chairman replied that, in point of fact, the weights of commodities are very frequently stated in terms of the stone as distinguished from the pound, and the question was how far such a practice should be approved.

The Master of the Mint thought such a practice should be opposed on principle.

The Chairman was prepared at once to recommend the adoption of 3½ lbs., except solely on the ground that it might be thought objectionable at this time to recommend the adoption of a new Imperial standard of this description, when the question of the introducing the metric system had not been fully considered by the Commission. This view was also taken by the Commission, and the subject was for the present deferred.

The question of a standard measure of the wine bottle was introduced by the Chairman, and reference made to the large number of different sizes of nominal quart bottles now in use.

The Warden pointed out that the introduction of a standard measure of a wine bottle would be quite independent of the question of the metric system, and that such a standard could be legalized under the authority of an Order in Council.

Sir John Lefevre read the clause of the Standards Act containing this provision, and the Commission agreed to the recommendation,—

That a standard measure of the wine bottle, equal to one-sixth of a gallon, and of the half wine bottle, equal to one-

6TH MEETING, 10 July 1868.

twelfth of the gallon, be constructed and legalized and added to the number of the official standards.

With reference to the preparation of their first Report, the Chairman stated that a draft had been prepared by the Warden of the Standards, and forwarded to him for his consideration, containing full statements of the result of the reverification of the official standards, as well as allusions in detail to the several subjects referred to the Commission, so far as they could be incorporated in their first Report. All the completed papers laid before the Commission, and bearing upon these subjects, were proposed to be appended. The Chairman was of opinion that it would be better now to make a shorter Report, alluding more generally to the several subjects and omitting numerical details; and that the completed papers by the Warden of the Standards which had been laid before the Commission should be appended to a subsequent Report.

The Chairman read a draft of his proposed Report, in which he recited the original Sign Manual warrant of appointment, the deaths of the Earl of Rosse and Lord Wrottesley, and the consequent reappointment of the Commission; and then alluded to the several subjects referred to the Commission, in the order in which they appear in the Royal Warrant.

After stating the results of the comparison of the official standards, the exact errors of which have been ascertained, the Report recommended the construction of new standards of avoirdupois weight, and stated that it would be sufficient for the present to correct the less important errors of the troy and bullion standards by noting the error of each and allowing for it in the official comparisons.

The construction, on the recommendation of the Commission, of a new line standard yard, with subdivisions, and having the length of the metre, also with subdivisions, marked upon it, was referred to in the Report, the metre having been laid down from the accurately verified platinum standard metre of the Royal Society, lent for that purpose to the Standard Department. This new line measure of length was constructed as a scientific standard, to be used with the microscopical comparing apparatus. It was recommended that a new measuring bar, with the yard and the metre marked upon it, and with similar subdivisions, should be constructed as a commercial standard of length, having a convenient apparatus attached to it for the official comparison, by means of a vernier, of subdivided local standards and measures of length.

On the subject of proposed additions to the number of standards, the Report recommended that a 10 lb. standard weight should be added. This was struck out, as the Warden pointed out that a 10 lb. standard was already provided, although no copies had been verified for the use of the local inspectors; practically the 10 lb. standard had been used only for the verification of the gallon measure of capacity, containing 10 lbs. weight of distilled water.

The Commission concurred in this view.

The Report recommended a series of decimal grain weights, as auxiliary standards, and in addition to the troy standard.

The Warden showed that such grain weights were absolutely required by the inspectors for determining the errors of commercial weights, and that they would be useful for all minute weighings. He pointed out that by law the grain was now an avoirdupois weight as well as a troy weight, the Imperial standard containing 7,000 grains; and that practically it would be better to recommend the decimal grain weights as avoirdupois weights, inasmuch as all local inspectors were provided with avoirdupois weights, and very few with troy weights.

The Chairman said that by custom the grain was connected with troy weights, but he altered his Draft Report in accordance with the Warden's suggestion.

The addition of standard gold coin weights of the full legal weight of the sovereign and half sovereign, and multiples of the sovereign, was recommended, as well as standards of the minimum legal current weight of the sovereign and half sovereign. Professor Miller suggested that the exact weight of each of these gold coin standards should be specified by the Commission, which was agreed to.

For additional standard measures of capacity, standards of the

Wine botttle - $= \frac{1}{6}$ gallon.
Half-wine bottle $= \frac{1}{12}$ „
4 fluid avoirdupois oz. $= \frac{1}{40}$ „
2 „ $= \frac{1}{80}$ „
1 „ $= \frac{1}{160}$ „

were recommended.

6TH MEETIN 10 July 18

For additional standard measures of length, the Draft Report recommended—

100 feet, divided into feet;
10 feet, into feet and tenths of feet;
Chain of 22 yards divided into links.

These were proposed as mural standards, their site being upon the space either on the south side of the Victoria Tower or on the north side of the New Palace Yard; that on the south side of the Victoria Tower being considered preferable. The chain might also be laid down on the floor of the Standards Office.

A subdivided yard;
2 feet; and
1 foot, with subdivisions.

These recommendations were agreed to.

The Report alluded to the provisional scale of errors already recommended by the Commission to be allowed in comparisons with the official standards.

Reference was made to the clause in the Standards Act, introduced by Lord Wrottesley, for extending the duties of the department to the comparison of weights and measures for scientific purposes or otherwise; and a recommendation was added that the department should verify weights and measures, in which special accuracy was required, for manufacturing firms, engineers, and other persons, for which a fee should be charged.

It was also proposed that these official comparisons should be extended to metric weights and measures, by means of the accurately verified copies of the French metric standards deposited in the department.

The Chairman having finished the reading of his Draft Report, said that if the Commission were satisfied with its general character (its principal points being as above stated), he would put it into more complete form, and have it printed and circulated. Two copies would be sent to each member, and one of these copies might be returned to him with any suggestions or corrections. It would then probably be sufficient if a corrected copy was printed and sent to each member for signature, so that it would not be necessary for the Commission to meet again before the recess.

The Commission concurred in the proposal.

The Warden's Paper No. X., including its continuation, with the reverification of the 10 oz. and 2 oz. bullion standards, and the determination of the standard weight of the troy standards, was then brought under notice. The Chairman and Professor Miller expressed their approval of the results of the official comparison as stated in this paper, which had been placed before them by the Warden for their consideration. Copies of this paper will be at once printed and circulated, and the comparison and reverification of all the remaining official bullion standards will be proceeded with as soon as possible, and the results shown in a further continuation of Paper X.

The Warden produced an estimate sent by Messrs. Tylor, of the expense of supplying a 10 gallon still and apparatus connected with it, as well as of their new gallon measure, viz.:—

	£	s.	d.
10 gallon still of copper lined with pure tin, condensing apparatus, &c.	35	0	0
With gas furnace, additional - -	3	0	0
60 gallon copper tank lined with tin -	20	0	0
Gun metal pump lined with tin - -	12	0	0
Conducting pipe from pump to tank, of pure tin, and fixing.	26	5	0
	£96	5	0
Approximate cost of new standard gallon measure.	50	0	0

Professor Miller recommended the conducting pipe from the still to be made on the French plan, and to ascend a short distance, so as to prevent any water being drawn with the steam into the condenser.

The Master of the Mint said that perhaps a stoneware receiver, with a tap, would be sufficient for the use of the department.

As the information required by the Commission as to the construction and use of this new gallon measure, and the apparatus required, had not yet been furnished by Messrs. Tylor, the matter was left to be dealt with by the Warden, upon consultation with the Chairman and Professor Miller. In the meantime, the Warden would proceed with the verification for Messrs. Tylor, as requested by

6TH MEETING, 10 July 1868.

them, of a gallon measure made of copper to aid their operations.

The Warden exhibited the official standard yard to the Commission, being a brass bar with steel terminations projecting above its upper surface, and showed the mode he had adopted for its verification, by fixing, inside the steel terminations, contact pieces, with a very fine line close to one edge, and thus making the comparison with one of the line standards by means of the microscopical apparatus. The comparisons were not yet finally completed, but the results hitherto showed that the official standard yard was about 0·0015 inch less than the Imperial standard. This deficiency is considerably within the allowance now provisionally sanctioned in the comparison of local standard yards (0·005 inch), and is in itself of no practical importance as regards the rude method hitherto practised in the department for the comparison of the local standard yards.

An instrument for comparing measures of length, made by Messrs. Troughton & Simms, was exhibited by the Warden of the Standards to the Commission. It consists of a brass bar with line measures marked upon it, having a rectangular bar of steel projecting and fixed to one end, with a second rectangular bar traversing along it, and carrying an arrangement of slides and a fine screw and vernier to show any difference in the measure compared, of 0·001 inch and upwards. This instrument is adapted for the comparison both of line measures and of end measures, and for both internal and external measurements, and is a copy of one now used for the accurate measurement at Woolwich of the internal diameters of mortars or guns, and the external diameters of shells, &c. It exhibits the principle upon which a new commercial standard of length may be constructed for the Standards Department, having the necessary apparatus connected with it, so as to be used for the comparison of subdivided local standards of measures of length. For this purpose it is proposed to have both the yard and metre marked upon it, with subdivisions similar to those of the scientific line standard measure lately constructed.

The Warden stated that Mr. William Simms had called his attention to the microscopical comparing apparatus for measures of length used by the late Standards Commission during the construction of the Imperial standard of length, and which, as he understood, was still lying in the lower cellar at Somerset House, under the apartments of the Royal Astronomical Society. This apparatus has not been used since 1855, and is the property of the Government. He suggested that, as it is only liable to injury in its present locality, it may be desirable to have it transferred to the Standards Department, where room can readily be found for it, and where it may be made serviceable.

The Commission concurred in this suggestion, but instructed the Warden to see the apparatus, and ascertain the state in which it is, before taking any steps with a view to its transfer to the Standards Department.

The Commission recommended that the necessary steps should be taken for providing a stereometer for the use of the Standards Department.

The Warden mentioned that he had written to Mr. Grubb, at Dublin, respecting a new revolving drill apparatus for marking verified measures of length, but had not yet received an answer. He explained the mode now practised of stamping verified copies of the standards, and exhibited the series of stamps used. No regulations for the stamping had hitherto been laid down, and some complaints of irregularities in the practice had been made; he proposed, therefore, to draw up a Minute upon the subject, so that a uniform practice should be adopted. This course was approved by the Commission, Professor Miller suggesting a slight alteration of the stamps to prevent the impressions from harbouring dirt.

The Warden called attention to the absolute necessity of including in the rooms of the department the two upper rooms in the Norman Tower corresponding in size with those now occupied, which are immediately underneath them, and where the microscopical comparing apparatus and the finest balances are now placed. If these upper rooms were used by other persons it would be fatal to the accuracy of the official comparisons, in consequence of the vibrations caused by persons moving on the floor above. The upper rooms will now also be required for the increased number of standards, particularly of foreign standards, deposited, and proposed to be deposited, in the department, as well as for the increased quantity of scientific apparatus.

The several rooms of the tower and in its basement, as well as the strong room in the basement of the Standards Office, where the Imperial standards are deposited, were inspected by the Chairman and Professor Miller, in company with the Warden of the Standards. Mr. Fincham, the surveyor of the Office of Works, was in attendance. Many of the rooms have iron doors, and in other respects may be considered as nearly if not quite fireproof.

6TH MEETING 10 July 186

The Commission agreed that the two upper rooms of the tower should be at once obtained for the use of the department, and that the necessary communication to the Office of Works should be made by the Warden for this purpose. It should also be intimated to the Office of Works that it was probable that further accommodation for the department would shortly be required, in consequence of the increased and increasing duties of the department, of the requisite apparatus, and of the number of its officers.

It was understood that the next meeting of the Commission would not be held until late in the autumn, probably early in November, as the Chairman should judge expedient, and of which due notice would be given to the members.

The Commission adjourned at 2 p.m.

G. B. AIRY,
Chairman.

SEVENTH MEETING.—FRIDAY, 26th FEBRUARY 1869, at 11 a.m.

7TH MEETING, 26 Feb. 1869.

PRESENT:

The Astronomer Royal (Chairman).
Lord Colchester.
Sir J. G. S. Lefevre, K.C.B.
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

Letters read from the Master of the Mint and from Mr. Cave regretting that they were unable to attend owing to domestic affliction and illness.

Secretary read summons convening the meeting.

The minutes of the sixth meeting were confirmed by the meeting, and signed by the Chairman.

The Chairman said it was desirable that the discussion on the introduction of the Metric system into the United Kingdom should take place at a full meeting of the Commission. He would therefore only suggest a few points for their consideration to-day, after the other business had been gone through. He then called upon the Warden to explain the progress of business since the last meeting of the Commission.

With reference to matters remaining since the last meeting, the Warden stated that he had written to Herr Brix, at Berlin, requesting information as to the progress of the introduction of the metric system into Prussia; and to General Morin, at Paris, requesting to be furnished with a complete set of verified metric weights and measures and apparatus, similar to those sent in 1852 to the American Government, together with an approved specimen of light cart for transport of Standards, and with an atlas of metric weights and measures, adding that any expense incurred would be readily defrayed on receiving a statement of the amount. This course had been reported by him to the Board of Trade, and considered by them to be within the powers of the Commission. He had not received any reply from either Berlin or Paris, and proposed to recur to the subject when transmitting any further papers of the Commission. Professor Miller suggested that a communication should be also made to M. Tresca, at Paris.

The Warden also reported that the Board of Works had on his application allotted to the Department the upper room of the Norman Tower, which would be fitted up when the expense was sanctioned in the Estimates.

That he had received no reply from Mr. Grubb respecting the revolving drill apparatus, and that Mr. A. Tylor had proposed to furnish one, and he had requested further information about it. The Commission concurred in this course.

That he had received a letter from Mr. Wyld, on the subject of the damaged standards from the Paris Exhibition, but without any satisfactory explanation.

He submitted a copy of his Report to the Board of Trade, of 14th August last, transmitting copies of his papers recently laid before the Commission, and their first Report, and calling attention to the course to be pursued; together with the Board of Trade's reply of 11th September, showing:—

That the question of the payment in Ireland of fees for stamping weights and measures had been referred to the Irish Government and the Treasury, both of whom considered that it would be injudicious to enforce

7TH MEETING, 26 Feb. 1869.

their payment, although the opinion of the law officers had been given that they were legally payable.

That the proposed departmental comparison of weights and measures, including those of the Metric system, as it involves the question of fees to be charged, must await legislation on the subject.

That the correction of the official Standards of troy weight, &c. was for the Commission to determine.

That the Board of Trade approved the adoption of the provisional scale of errors to be tolerated; and the transfer of the foreign Standard weights from the Mint. These weights, contained in a cabinet with 72 drawers, were delivered to the Department on 1st September.

That the Board of Trade had finally agreed that the expenditure for Standards and Apparatus, recommended by the Commission, should be charged to the Department and not to the Commission, and that they had obtained the Treasury sanction for incurring the estimated expenditure of 700*l.* for carrying out the recommendations.

He had accordingly directed Messrs. Troughton and Simms to construct a new commercial measure of length with the subdivided yard and metre marked on the same bar, and suitable apparatus for comparison. Mr. James Simms' plan was exhibited to the Commission. He had also directed them to construct a stereometer, for which Professor Miller had some plans.

He had directed Messrs. Tylor to proceed with his 10-gallon measure, and to supply and fix a still. These were now in progress. He had also ordered them to deliver the set of metric standards, which he had received on 10th February.

Mr. Oertling had been directed to construct a new set of avoirdupois Standards of gun metal, similar in form to the existing official Standards. On this point the Astronomer Royal and Professor Miller had been consulted. The practical details of the construction of these Standards were left by the Commission to Professor Miller and the Warden.

With respect to matters arisen since the last meeting, the Warden delivered to the Commission:—

Paper III.—III.—Further addenda to Appendix G. of Paper III.
X.-I.—Continuation of Paper X.
XII.—Abstract of returns from inspectors, &c. in Great Britain.
XVI.—On the question of the introduction of the metric system into the United Kingdom.

He referred to the information contained in the first of these papers as to the recent occurrence for the first time of the actual inspection of troy weights, and to their defective Standard weight, not being stamped according to law, as well as to the evidence to the same effect in Paper XII., showing that the powers of the inspectors, which were established by law in relation to troy weights, had never been practically enforced. As the troy weights used for apothecaries' weights had been shown in Paper I., p. 3, to have been legally discontinued and avoirdupois weights substituted, it might be a matter for serious consideration whether troy weights should not now be discontinued as legal weights, excepting perhaps the bullion ounce. He thought it a well founded objection to the Imperial system that there should be two different series of weights allowed by law, avoirdupois weights and troy weights.

After some discussion, it was resolved on the motion of the Chairman,—

That as the existing system appeared to be grievously defective in regard to the inspection and the enforcing the true standard weight of troy weights in common use, the Warden of the Standards be requested to collect further information on the administration of the law relating to troy weight.

The Warden then mentioned a letter from Mr. Gregg, Inspector of Middlesex, stating the frauds commonly practised from selling potatoes by heaped measure, though heaped measure was illegal. It was agreed that the law was clear upon the point, and required no consideration of the Commission.

With regard to Paper X.-I., the Warden referred to his suggestion (p. 21.), which had been approved by the Astronomer Royal, that the Standards Department should be provided with a complete set of legal Standards of every description, as standards of reference, and with a second complete set of official copies for the ordinary Departmental comparisons.

7TH MEETING 26 Feb. 186

The Chairman mentioned the course he had suggested for preserving Kater's 10 lb. weight, as a historical standard, and providing a duplicate of the gilt gun-metal 10 lb. weight of 1855, for Departmental comparisons, upon the principle that so important a standard as Capt. Kater's weight, from which the existing Standard unit of capacity, the gallon, had been derived, should be preserved as far as possible unaltered. The Commission concurred in these views.

The Warden called attention to the inexplicable difference in the 10 lb. gilt gun-metal weight of 1855, as well as in the Standard 62·321 lb. weight (the base of the Standard cubic foot measure, which was the legal unit of gas measure), and its three brass copies, since their original verification. Professor Miller had subsequently attended at the office with Mr. Oertling, and had again made some comparisons but with exactly the same results as stated in Paper X.-I. He also exhibited Mr. Crosley's 62·321 lb. weight, which had been compared and had agreed with the Standard in 1859, and was now found to be very nearly of the Standard weight, although the other four weights differed as stated. This fact rendered the whole matter still more inexplicable. Nothing, however, now remained but to adjust the several weights to their true standard weight, for which Mr. Oertling had received official directions. This course was assented to by the Commission.

He referred to the Petroleum Act of 1868, and the duties imposed in respect of it on the inspectors of weights and measures, and to an application to the Board of Trade for the requisite apparatus approved by them, his own opinion having been given that the approval or intervention of the Board of Trade was neither provided for in the Act nor was it practically required. A copy of the Act was given to each member of the Commission. They agreed with the Chairman, that there was nothing in the Act calling for their interference, as the magistrates were enabled to call for evidence of the correctness of the test apparatus used, and that it did not appear necessary that the Board of Trade should approve of the apparatus.

The existing anomaly of the law relating to the inspection of gas meters was then explained by the Warden, who referred to the Acts and Parliamentary Papers upon the subject, already circulated to the members of the Commission, and it was left to him to bring the matter further under the consideration of the Commission.

A copy of Dr. Wild's Report upon the reverification of the Swiss Primary Standards, which had been forwarded by the Foreign Office to the Board of Trade, was laid before the Commission by the Warden of the Standards. He has applied for some more copies of the Report. The Swiss Standards consist of copies of the metre and kilogramme des Archives, and of the Swiss primary units, the foot=0·3 metre, and the pound =0·5 kilogram.

The Chairman then brought forward the question of the introduction of the Metric system into the United Kingdom, by way of a preliminary discussion.

He thought that the Commission were not justified in entering into the question of Indian weights and measures as it had not been specifically referred to them, and there were many complications on the subject which rendered their interference inexpedient; although the opinion of the Commission as to the introduction of the Metric system into the United Kingdom would probably materially affect the decision as to its introduction into India.

The Warden entirely agreed with the Chairman that the Commission was neither asked nor required to give an opinion as to the introduction of the Metric system into India; but he pointed out that the Secretary for India had asked for the opinion of the Board of Trade upon the subject, and also "whether any measure was under consideration for a change in the weights of this country." The Board of Trade had asked for his views upon the subject, and upon communicating with them, they agreed with him that the whole question turned upon the opinion of the Commission on the general question of the introduction of the Metric system into this country, and that this opinion should be given before a satisfactory reply could be made to the Indian Department. It was with respect to this general question that he thought it requisite that evidence of the actual introduction of the Metric system into other countries, especially into Germany and the United States of America, and of its proposed introduction by the Indian Government into India, should be laid before the Commission.

After some general conversation upon the subject, the further consideration of the subject was deferred till the next meeting, which was fixed for Saturday, 6th March, at 11 a.m.

7TH MEETING, 26 Feb. 1869.

The Commission then inspected the new Metric Standards in the Tower room, and the fittings of the Sheepshanks Apparatus in the Strong room.

The Chairman and Professor Miller agreed with the Warden that the thermometers used in the comparison of Standards in the Standards Department should be tested at Kew.

Adjourned at 2.30 p.m.

G. B. AIRY,
Chairman.

8TH MEETING, 6 Mar. 1869.

EIGHTH MEETING.—SATURDAY, 6th MARCH 1869, at 11 a.m.

PRESENT:

The Astronomer Royal (Chairman).
Lord Colchester.
The Right Hon. S. Cave, M.P.
Sir J. Shaw Lefevre, K.C.B.
The President of the Royal Society.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

The Commission proceeded to consider the question of the introduction of the metric system into the United Kingdom.

With reference to Paper XVI. upon the subject, delivered by the Warden of the Standards, the Chairman, whilst acknowledging the value of the information contained in it, doubted whether that portion of it which related to the proposed introduction of the metric system into India could properly be entertained by the Commission, as the question of Indian weights and measures had not been in any way referred to them, and they were neither required nor were competent to express an opinion upon it. At any rate he thought if such information were received by the Commission, they should pass a precautionary resolution with respect to it.

After some discussion the members generally concurred in the views of the Chairman, and the following resolution was passed unanimously:—

> "In receiving Paper XVI., communicated by the Warden of the Standards, the Commission expressly record that under the terms of their constituent Warrant, they are not competent to take any action in reference to Standards for India."

The Chairman suggested that the paragraph in page 16 of Paper XVI., relating to Russian corn measures, should be omitted, which was agreed to.

The Warden pointed out that he had inserted some additional information relating to the mode and period of introducing the metric system into countries which had adopted it from France, as well as a paragraph suggesting the adoption of the French nomenclature.

With respect to the relative amounts and increase of our foreign and home trade, the Chairman referred to the importance of the information contained at p. 36, and to some additional information proposed by the Warden to be inserted as to the amount of foreign and home letters passing through the post-office.

Mr. Cave called attention to the distinction that should be made, in stating the amount of our foreign trade, between colonies using imperial weights and measures, and foreign countries.

The Chairman remarked upon the importance he attached to the proposal of a conspicuous distinction being authoritatively made between metric and imperial weights and measures, as such a regulation would tend much to obviate the objection he had entertained to the use of metric weights and measures in public shops, as expressed by him some time since in a paper circulated amongst the members of the Commission. At his suggestion the Warden had drawn up a separate resolution bearing upon this point.

The Commission then proceeded to the concluding part of the Paper XVI., containing practical suggestions for dealing with the question of the introduction of the metric system into the United Kingdom.

After full consideration and discussion, many verbal and formal amendments were made in the resolutions as suggested in Paper XVI., but without any material alteration in their substance; and the following resolutions were unanimously agreed to:—

1. Considering the information which has been laid before the Commission,—

Of the great increase during late years of international communication, especially in relation to trade and commerce;

Of the general adoption of the metric system of weights and measures in many countries, both in Europe and other parts of the world, and more recently in the North German Confederation and in the United States of America;

Of the progress of public opinion in this country in favour of the metric system as a uniform international system of weights and measures;

And of the increasing use of the metric system in scientific researches, and in the practice of accurate chemistry and engineering construction;

> We are of opinion that the time has now arrived when the law should provide, and facilities be afforded by the Government, for the introduction and use of metric weights and measures in the United Kingdom.

2. Considering,—

That there is no immediate cause requiring a change in the existing system of legal weights and measures of the country for the purposes of internal trade;

That the statutable values of the fundamental imperial units are adopted in use without the slightest variation throughout the whole of the British isles;

That the primary imperial standards are as perfect as can be made by modern skill and science, and that the whole series of official standards are now most accurately verified in relation to the primary standards;

That a very large number of copies of the official imperial standards, accurately verified, are now in use by the local inspectors of weights and measures;

That it is estimated there are nearly 30 millions of ordinary weights and measures of the existing imperial system now in common use;

That at the present time there is no evidence to show that the numerical majority of traders and their customers in this country are dissatisfied with the imperial system now in use, or that they desire to substitute the metric system for it;

> We are of opinion that the general introduction of the metric system should be permissive only, and not made compulsory by law after any period to be now specified, so far as relates to the use of metric weights and measures for weighing and measuring goods for sale or conveyance; and that verified copies of the legalized official metric standards should be provided by the local authorities for inspectors of such districts as may require them.

3. Considering that during the concurrent use of the metric and imperial systems, it will be expedient to prevent as far as possible metric and imperial weights and measures from being accidentally or fraudulently substituted for each other;

> We are of opinion that authoritative regulations should be established under which each series may be readily and easily distinguished, by the adoption of conspicuous distinctive forms or marks for the several weights and measures; and by such other mode as may be determined upon after due inquiry.
>
> 4. We are of opinion that it is expedient that customs duties should be allowed to be levied by metric weight and measure, as well as by imperial weight and measure; that the use of the metric system, concurrently with the imperial system, should be adopted by other public departments, especially the Post Office, and in the publication of the principal results of the statistics of the Board of Trade, as well as for the admeasurement and registration of the tonnage of shipping;
>
> 5. And that mural standards of the metric system be exhibited in public places.

6. Considering,—

That the metric system, as adopted in other countries, includes the relation of coinage to weights and measures, particularly in its uniform decimal scale;

And that the advantages of the introduction of the metric system into this country, as an international system of weights and measures, would be much increased by establishing a corresponding international system of coinage, in regard to a unit and to a decimal scale;

> We are of opinion that, even if the difficulties of establishing an international unit of coinage cannot be at present overcome, yet the decimalization of our system of coinage, which is in the power of the Government, would be very useful to the public.

7. Considering the great national importance of the question of the introduction of the metric system of weights and measures into this country,—

> It appears to us essential that any measure for this object should be proposed to Parliament by the Executive Government.

8. Considering that the Commission will very shortly enter upon the questions referred to them relating to

8th Meeting, 6 Mar. 1869.

the system of local inspection of weights and measures throughout the United Kingdom,—

> We are of opinion that it is expedient that no legislation should take place with respect to the metric system until the whole subject of the weights and measures of this kingdom be brought before Parliament in one Bill.

The Master of the Mint laid before the Commission a paper, in which he proposed that troy weight should be discontinued and the use of metric weights enforced by law in substitution for troy weights in all cases in which they are now used. He considered that although the general introduction of metric weights and measures for trade purposes might in the first instance be made permissive only, yet that their use should to some extent be made compulsory, else the mere permission to use them in the home trade of this country would be practically a dead letter. And he instanced the case of the first introduction of the florin, at a time when there was no call for it by the public, and to its use being practically established by the number of florins coined, and the discontinuance of the coinage of half-crowns.

It was agreed that the Master of the Mint's Paper should be printed and circulated, and considered by the Commission at their next meeting, which was fixed for Saturday, 20th March, at 11 a.m.

The Commission adjourned at 3.30 p.m.

G. B. Airy,
Chairman.

9th Meeting. 20 Mar. 1869.

Ninth Meeting.—Saturday, 20th March 1869, at 11 a.m.

PRESENT:

The Astronomer Royal (Chairman).
Lord Colchester.
The Right Hon. Stephen Cave, M.P.
Sir J. G. S. Lefevre, K.C.B.
The President of the Royal Society.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

The minutes of the seventh and eighth meetings were confirmed by the Commission, and signed by the Chairman.

The meeting proceeded to consider the subject of their Second Report, upon the metric question.

The Chairman read his draft report, for any suggestions of the Commission as to its arrangement and tendency.

The Commission agreed that this draft would form a good basis for their Second Report, and that it should be printed and circulated.

The paper delivered by the Master of the Mint on the proposed abolition of troy weight, and compulsory substitution of metric weight, which had been printed and circulated, was then read by the Chairman.

The Master of the Mint read the following letters upon the subject of his paper: From the Chief Cashier of the Bank of England, showing that he was not altogether opposed to the substitution of metric for troy weight; from Mr. Mocatta, as generally representing the bullion trade; from Dr. Sharpey, a member of the General Medical Council; from Dr. Redwood, professor of chemistry to the Pharmaceutical Society.

The Warden inquired of the Master of the Mint how far the decimal bullion weights were used by bullion merchants. The Master of the Mint believed they were in general use. The meeting agreed that the three last-mentioned letters should be printed and circulated, that from the Chief Cashier of the Bank of England appearing to require further elucidation of the views of the Bank upon the matter in question.

Mr. Cave suggested that an official communication should be addressed to the Governor of the Bank of England, for a more decided expression of the opinion of the Bank upon the subject. The Commission concurred in this suggestion, and it was left to the Warden to act upon it.

The Chairman referred to the short paper on the subject of troy weight prepared by him, and circulated; and read a more detailed paper by the Warden of the Standards containing points for consideration, with reference to the proposal of the Master of the Mint, and including some information as to the number of troy standards in use, and weights and measures stamped by inspectors, and the number of persons using troy weight. The Master of the Mint remarked that a large number of the trading persons stated as using troy weight, merely bought by troy weight and did not sell by it.

9th Meeting, 20 Mar. 1869.

The meeting agreed that this paper by the Warden of the Standards should be at once printed and circulated; the several papers relating to troy weight being arranged together.

As to the evidence to be taken with reference to the proposed abolition of troy weight, the Warden stated that he had inquired as to the practice of auctioneers in selling gold and silver, and ascertained that they could give no evidence of any importance, as they merely sold by the troy ounce, and could as easily sell by the avoirdupois ounce, or by the gramme. The Chairman remarked that his object in naming auctioneers in his paper was to obtain statistical information of the amount thus sold by the ounce. The Warden suggested that the information might be better obtained through the Inland Revenue Department, and he would make inquiries upon the subject. He added that the persons who would probably be most affected by the abolition of troy weight were manufacturers who were accustomed to use gold and silver in definite proportions, and for mixture with alloys, their arrangements being based on the troy ounce. He suggested that the best evidence might perhaps be obtained from amongst them, and the leading pawnbrokers. Mr. Cave suggested that some evidence might also be obtained from the Goldsmith's Company. It was left to the Warden to endeavour to select persons from whose evidence the requisite information might be obtained for the Commission, and to communicate with the Chairman.

The Chairman having ascertained that Saturday was a convenient day of the week for the meetings of the Commission, appointed Saturday, April 3rd, at 11 a.m., for the next meeting, and for the further consideration of their Second Report, as well as of the Master of the Mint's proposal in relation to troy weight.

The Commission adjourned at 1.15 p.m.

G. B. Airy,
Chairman.

10th Meeting, 3 April 1869.

Tenth Meeting.—Saturday, 3rd April 1869, at 11 a.m.

PRESENT:

The Astronomer Royal (Chairman).
Lord Colchester.
The Right Hon. Stephen Cave, M.P.
Sir J. G. S. Lefevre, K.C.B.
The President of the Royal Society.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

The minutes of the ninth meeting were confirmed by the Commission and signed by the Chairman.

The Chairman stated that the Warden had seen Mr. Prideaux, the Secretary to the Goldsmiths' Company, on the subject of the Master of the Mint's proposal for the abolition of troy weight, and had made a minute of their conversation. This minute was ordered to be printed.

The Warden stated that he had been in communication with Messrs. Hancock, Hunt and Roskell, Elkington, and Garrard, who, as he was informed, were the only manufacturing goldsmiths and silversmiths in London, and with Mr. Attenborough as representing the retail dealers. Their evidence on the abolition of troy weight would be forthcoming at a future time.

He added that in the meantime, with the concurrence of the Master of the Mint, he had prepared a draft clause relating to the question of the abolition of troy weight, and he proposed to lay it before the Commission for their consideration during the deliberation on the Draft Report of the Chairman.

It was left to the Master of the Mint and the Warden to arrange as to the evidence which it might be desirable for the Commission to have before them upon this question.

The meeting then proceeded to consider their Second Report, each paragraph of the Draft Report being read by the Chairman, and discussed seriatim.

After considerable discussion and several verbal amendments, the Preamble and Clauses 1 to 6 were agreed to. Clause 7 being read, Professor Miller pointed out that "livre" and "sou" were merely the old names applied to the half-kilogram and the 5-centime piece, and the paragraph, as now worded, might be taken to imply that the old pound and the sou piece were still in use in France, which was not the fact. The Master of the Mint said the sou was called in when the old French copper coinage was withdrawn from circulation five years ago. He suggested

10TH MEETING, 8 April 1869.

that the words "but among the lower classes," should be struck out, and "although" inserted. This was assented to, and the words "for the half kilogram and the piece of "five centimes" having been inserted after "*sou*," the clause thus amended was agreed to.

Clauses 8, 9, 10 were agreed to after some discussion and several verbal alterations.

An addition proposed to § 11 by the Warden, reciting that in this country the Executive Government had far less power than was exercised in other European countries of compelling obedience to the law in all small transactions of trade, against the wishes of the public, was approved, and the clause was agreed to.

Clause 12 was also agreed to, with some verbal amendments.

A new clause, prepared by the Warden, suggested as § 13, relating to the discontinuance of troy weight, and which had been proposed by the Master of the Mint, was agreed to.

Clause 13, altered to 14, was agreed to.

On reading Clause 14, now 15, the Master of the Mint objected to the words which specifically recommended the Pound and Mill Scheme, and proposed to strike them out, leaving only a general recommendation of a decimal system of coinage. This was concurred in, and the clause as altered was agreed to.

The President of the Royal Society proposed to amalgamate § 15 with the preceding clause, which was agreed to.

On § 16 being read, the Chairman proposed to transfer from the end of Resolution (2), and to add to (1) the words—

"And that verified copies of the official Metric Standards should be provided by the local authorities for inspectors of such districts as may require them."

The Warden proposed also that these words should be preceded by—

"That for this object Metric Standards accurately verified in relation to the primary Metric Standards at Paris, and deposited in the Standards Department of the Board of Trade, should be legalized."

These proposals were agreed to.

The Warden proposed to insert as Resolution (2)—

"(2.) Considering the advantages of adopting in an international system not only uniform weights and measures, but also uniform names; and that although there may be well founded objections to the inconvenient, length and occasional similarity, both to the eye and ear, of the French nomenclature, yet it is probable that these names will become familiar by custom, and obtain popular abbreviations;

> "We think that the French nomenclature, as well as decimal scale of the Metric system, should be introduced in this country."

This was agreed to.

In Resolution (2), now (3), the insertion of the word "general" before "change," in the first paragraph, was proposed by Sir J. Lefevre, who also suggested the substitution of "any considerable portion" for "the numerical majority," in the sixth paragraph. These amendments were approved, the concluding words of the Resolution, "And that verified copies," &c. transferred to Resolution 1, having been struck out, the Resolution thus amended was agreed to.

Resolution (3), now (4), was agreed to; "Metric and Imperial" being altered to "Imperial and Metric."

Resolution (4), now (5), was agreed to; as also (5), now (6), upon the insertion of the words "as well as of the Imperial system" after "Metric system."

Resolutions (6), (7), (8), were agreed to, as (7), (8), (9).

The Report thus amended was unanimously agreed to by the Commission, and ordered to be printed for signature.

The following Papers were proposed to be annexed as the Appendix to the Report:

I. Memorandum on the policy of introducing Metric Standards. By the Astronomer Royal.

II. Paper, No. XV., on the Metric System as established in France. By the Warden of the Standards.

III. Paper, No. XVI., on the question of the Introduction of the Metric System into the United Kingdom. By the Warden of the Standards.

It was arranged that Paper XV. should be revised by the Chairman and the Warden, so as to shorten it by omitting some of the details.

The next day of meeting was left for the Chairman to appoint, and the Commission adjourned at 3.30 p.m.

COLCHESTER.

11TH MEETING, 12 May 1869.

ELEVENTH MEETING.—WEDNESDAY, 12th MAY 1869, at 1.30 p.m.

PRESENT:

The Lord Colchester, in the Chair.
The Right Hon. Stephen Cave, M.P.
Sir J. G. S. Lefevre, K.C.B.
The President of the Royal Society.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

The Astronomer Royal being absent from indisposition, Lord Colchester took the chair, in accordance with the request of the Astronomer Royal.

The minutes of the tenth meeting were confirmed and signed by the Chairman.

The Warden stated that after communicating with the Home Office, the Second Report of the Commission bearing the signatures of all the members, had been transmitted to the Home Secretary for presentation to Her Majesty. Two more copies, with the Appendix, would be transmitted to the Home Office for presentation to Parliament, as soon as the whole of the Appendix was printed.

He added that upon further consideration the Astronomer Royal assented to the whole of Paper XV., on the Metric system as established in France, being appended to the Report, provided this met with the concurrence of the Commission. He had also proposed to the Astronomer Royal for his approval, to append a paper "On the relation "of the kilogram, the unit of the metric weight, and of "the litre, the unit of metric capacity, to the metre, the "unit and fundamental base of the metric system," as well as a table of decimal equivalents of Imperial and Metric weights and Measures, and he gave an explanation of the contents of these papers. This course was approved by the Commission, and the insertion of these two papers as Appendices to the Second Report was left to the judgment of the Astronomer Royal.

The Warden after referring to Sir G. Shuckburgh's determination, in 1797, of the weight of a cubic inch of water, which had been confirmed by Kater, in 1821, and to the later determination by Kupffer, exhibited to the Commission the four brass cubic inch measures constructed in 1758, containing respectively 300, 60, 12, and 2 cubic inches, and stated that he proposed to ascertain from them the weight of a cubic inch of water, so soon as the arrangements of the still for distilled water, and a micrometrical apparatus which he had ordered from Messrs. Troughton and Simms, were completed.

Professor Miller said that the published correspondence between Gauss and Schumacher contained some suggestions upon the mode of determining the weight of water which were worthy of consideration. He thought it desirable that further observations should be made for accurately determining the weight of a cubic inch of water, considering the advantage to be derived from the increased scientific knowledge acquired since the time of Sir George Shuckburgh, the results of whose observations have been ever since accepted in this country and adopted in our weights and measures' laws. But the operation was a very difficult and delicate one.

The Warden laid before the Commission copies of Paper XVII.–1, on the proposed abolition of troy weight, with opinions of Mr. Prideaux, Mr. Attenborough, and Messrs. Elkington & Co., together with a list of proposed questions to the witnesses to be examined.

He read a letter from Mr. John Hunt, who stated that he was unable to attend to-day, but would write replies to the proposed questions.

After some conversation on the best equivalent unit in substitution of the troy ounce, the Master of the Mint stated his opinion that the kilogram would be the most convenient unit for the bullion trade.

A shorthand writer having been introduced the following witnesses were examined:

Mr. Stewart, of the firm of Messrs. Hancock and Co.

Mr. James Garrard, of the firm of Messrs. Garrard & Co.

The following witnesses were proposed for examination at the next meeting of the Commission.

Mr. Attenborough.
Mr. John Hunt.
Mr. Sharpe, of Goldsmiths' Hall.
Mr. Ralph Heaton, of Birmingham.

The Warden said that he had received no reply from the Governor of the Bank of England, but he had been informed by Mr. Cave that the subject of the abolition of troy weight, and substitution of the metric system, was under consideration at the Bank.

11TH MEETING, 12 May 1869.

Mr. Cave said that he had just seen the Governor of the Bank, and that a reply would probably be sent to the Commission to-morrow. That the Bank were unwilling to give a formal opinion at any length upon the question, other than that they did not object to the change, and that Mr. Forbes, the chief cashier, could give evidence upon the subject and make known their views.

The Master of the Mint thought it might be desirable to have some evidence of the opinion of the Pharmaceutical Society.

Professor Miller considered it would be useful to have on record the reasons why avoirdupois weight was substituted for troy weight in pharmacy.

The Warden said he proposed immediately to communicate with the Board of Trade, in order that a request might be made through the Foreign Office to the Minister of Commerce at Paris, to furnish the Department with a complete set of metric standards and apparatus similar to that sent to the American government, together with a specimen of a travelling cart for the Vérificateur's apparatus.

He had been in communication with the Astronomer Royal and Professor Miller on the question of the construction of an end standard metre for the Department, and it was proposed that a bar of steel gilt, with spherical ends of agate or other very hard material, should be constructed by Messrs. Troughton and Simms. He exhibited to the commission two steel bars, one of them gilt, which were constructed under Mr. Sheepshanks' directions, as standard yards. The new end metre could be verified with the two platinum metres of the Royal Society. He stated that the contact piece now used with the microscopical apparatus had plane rectangular ends to be pressed against the spherical terminations of the end standard yards, and he had directed Messrs. Troughton and Simms to furnish two additional contact pieces with spherical ends, which could be used with the platinum end standard metre of the Royal Society, and other similar standards à bouts with plane rectangular terminations.

Professor Miller thought it would be very desirable that an application should at the same time be made to the Austrian government for the purpose of obtaining a copy of the Standard Klafter at Vienna, as recommended by the Astronomer Royal in his memorandum upon Metric Standards.

He considered that a steel bar would be preferable to gun metal or brass, as being less affected by variations of temperature, and that agate ends to the steel bar were objectionable, on account of the unequal hardness of different portions of a piece of agate, and its very porous nature. He would prefer sapphire, which had been used in the Prussian three-feet standard bar, two pieces of which would not be very costly, as opaque or badly coloured sapphire might be selected. Perhaps the best material for the ends would be an alloy of iridium and osmium, such as is used for the tips of gold pens and for compass pivots. It is exceedingly hard, and can be soldered to other metals. Such a junction of a hard material would be much more complete and satisfactory than that of a truncated cone of stone "shrunk" into a cavity at the end of a bar.

He suggested also that a comparison of the new metre should, if possible, be made with Steinheil's glass metre, which had been very accurately compared by Steinheil in 1837, with the Metre des Archives.

It was understood that inquiry should be made if these two last suggestions could be carried out, and that in the meantime the Warden should take steps for communicating with the French and Austrian governments.

The Warden stated that he had arranged to go to-morrow morning to Messrs. Troughton and Simms' factory at Old Charlton, to see some Standards of length with comparing apparatus attached, similar to that proposed for the Standards Department, and which had been constructed by order of the Sultan for the Arsenal at Constantinople. He would be glad if any of the members of the Commission would accompany him.

With respect to the future meetings of the Commission, the Warden said that his Paper No. XIV., containing a "Summary of information relating to the existing system "of inspection of weights and measures, with practical "suggestions for its improvement," was now in type and nearly ready for distribution, when the whole matter would be ripe for the consideration of the Commission. As it was proposed to examine many witnesses upon this large subject, much more frequent meetings of the Commission would be requisite in order to complete the inquiry and make their Report by the end of the present Session.

After arranging that the next meeting should be held at 11 A.M. on Saturday 29th May, the Commission adjourned at 4.30 P.M.

COLCHESTER.

12TH MEETING, 29 May 1869.

TWELFTH MEETING.—SATURDAY, 29th MAY 1869, at 11.30 a.m.

PRESENT:

The Lord Colchester, in the Chair.
The Astronomer Royal.
Sir J. G. S. Lefevre, K.C.B.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

At the request of the Astronomer Royal, Lord Colchester took the chair.

The minutes of the eleventh meeting were confirmed and signed by the Chairman.

A letter was read from the President of the Royal Society stating that he was unable to attend, as he had to be present at a meeting of the trustees of the British Museum.

With respect to the question of the proposed abolition of troy weight, and compulsory substitution of metric weight, the Warden read a letter from Mr. Forbes, chief cashier of the Bank of England, stating that he and Mr. Johnson were quite ready to give evidence before the Commission, but that they could state only their individual opinions, not being authorised to communicate the views of the Governor and Company of the Bank of England.

He also read a letter from Mr. Prideaux, stating that Mr. Sharpe of Goldsmiths' Hall concurred in his views as to the proposed abolition of troy weight, and that they were unable to add anything to the minute of the Warden of the Standards on the conversation between the Warden and Mr. Prideaux upon this subject.

The corrected printed proofs of the evidence of Mr. Stewart and Mr. J. Garrard were put in.

Mr. Ralph Heaton, of "the Mint," Birmingham;

Mr. Charles Houle, manufacturing silversmith, Clerkenwell;

Mr. George Forbes, chief cashier, Bank of England;

Mr. A. Johnson, chief clerk of the bullion office, Bank of England,

were then introduced and examined.

A letter was read from Mr. J. Hunt, of the firm of Hunt & Roskell, enclosing replies to the printed questions relating to the abolition of troy weight, &c.; as well as similar replies from Mr. Robert Hennell, of the firm of Hennell & Sons, silversmiths, Arundel Street, Strand.

It was stated by the Master of the Mint that practically the kilogram was the unit of weight for the bullion trade in France.

The Astronomer Royal remarked that the inspection of troy weights appeared to be unnecessary in shops where goods were not bought and sold by weight.

The Warden explained that practically all silversmiths who kept shops, and bought and sold gold and silver wares by weight, took out pawnbrokers' licences, and that inspection of their weights was evidently required. It would be difficult to discriminate between those shops who sold by weight and those who did not.

The Warden inquired whether any further evidence on the question relating to troy weight should be heard.

The Master of the Mint said that plenty of witnesses might be found to oppose the metric system, but he thought it would appear that they knew nothing of the metric system.

It was agreed that the evidence already given should be printed as soon as possible, and when it was in the hands of the members they would be able to consider whether any or what further evidence was necessary.

The Warden laid before the Commission a letter from Mr. Ernest Seyd to the Chairman transmitting a copy of his books on "Bullion and Foreign Exchanges," and on "the question of seignorage and charge for coining," and offering to give his evidence upon these subjects.

The Astronomer Royal said that Mr. Seyd's evidence should more properly have been given before the International Coinage Commission, and would hardly be required for the Standards Commission, the subject of the coinage not being before them.

The Secretary was desired to acknowledge and thank Mr. Seyd for his letter and books.

The Warden explained the alterations and additions which had been made by him, with the consent of the Astronomer Royal and approval of Professor Miller, to the Appendices to the Second Report, viz., Appendices V., VI., VII.

12TH MEETING, 29 May 1869.

As to the table of decimal equivalents (Appendix VII.), the Warden explained that the tables had been drawn up in the form best suited to the requirements of the Standards Department and probably for scientific purposes; and for that object it appeared to be necessary to have a certain number of decimals, particularly for the equivalents of multiples of the units. He proposed therefore to insert at least five places of decimals throughout the table of equivalents.

The Warden explained that he had made official application through the Board of Trade to communicate with the French and Austrian Governments for copies of their standards; he inquired whether application should also be made to the Swiss Government for a copy of the new Swiss standard of length=0·9 metre.

Professor Miller thought it would be far preferable to have a copy of the glass metre, which had been constructed by Steinheil, and very accurately verified by him with the metre des Archives, before this primary standard was damaged; and that a copy of Steinheil's quartz kilogram, which had been carefully verified with the kilogramme des Archives, should also be deposited in the Standards Department.

It was not considered to be requisite that copies of any other foreign standards should now be procured, those only having an historical interest, or which were primary standards, constructed with scientific accuracy, being immediately desirable.

The Warden referred to the tables of equivalents of foreign coins, weights, and measures, prefixed to the foreign statistical tables of the Board of Trade, which were annually presented to Parliament, and to the very many demands made for these tables of equivalents on the part of the public. He produced a copy of the Annuaire du Bureau des Longitudes, officially published at Paris, and considered that it would be of great public advantage if a similar work was officially published in this country. Probably the most reliable Imperial equivalents of foreign weights and measures would be found in, or computed from, Kupffer's large work on Russian weights and measures, and their foreign equivalents, and in Dr. Kelly's Cambist.

The Commission concurred in these views.

The Warden stated that he had been in communication with Mr. Hilgard of the Weights and Measures Office at Washington, who had come over to this country upon business connected with the introduction of the Metric System and the proposed international coinage.

The Warden laid before the Commission Paper XIV., on the system of inspection of weights and measures, and referred briefly to his suggestion of appointing distinct officers, first, for the comparison and verification of weights and measures, by stamping them as a certificate of such verification duties requiring special qualifications for their accurate execution; secondly, and for the inspection of weights and measures used in shops and other places where commodities were bought and sold, with the view of detecting unjust or fraudulent weights and measures, and the punishment of offenders; which appeared to be more strictly a Police duty. It had been found necessary to make this distinction in France, when establishing an improved system of inspection of weights and measures there, and the same distinction had been made in this country previously to the establishment of the present system of inspection, by appointing distinct local officers as stampers and as examiners of weights and measures.

In answer to the Astronomer Royal, who thought the duties of inspection involved also those of verification, the Warden said the broad distinction between the two duties was, that the Verifier would test, and certify by stamping, the *truth* of all weights and measures brought to him for that purpose, either for original verification, or for subsequent reverification, from time to time; whilst the Inspector would be empowered to enter shops and other places, and to examine and detect such weights, measures, and balances as were manifestly *untrue and fraudulent*, or any fraudulent dealings connected with them, and prosecute the offenders against the weights and measures laws.

Sir J. Lefevre approved of the suggestion, which appeared to him the only practical means of improving the present system of inspection.

The Astronomer Royal thought that the questions in Paper XIV. were the most important of the matters referred to the Commission, and would require much consideration. He was of opinion that if the duties of inspection were to be exercised by the Police, the officers should be specially selected for such duties.

The Warden pointed out that this subject was one for which the Government and Parliament were waiting for the report of the Commission. The evidence of several witnesses who were practically acquainted with the working of the present system of inspection, the construction, cost, and condition of the local standards, weights and measures, &c., would be required to ascertain how far the proposed new scheme of verification and inspection would be likely to be successful. For this purpose, and with a view of making as much progress as possible during the present Session, he suggested that the Commission should have frequent meetings, say once a week, the whole subject being now ripe for their consideration.

12TH MEETING, 29 May 1869.

The Astronomer Royal said that he would be quite unable to attend the meetings of the Commission after the beginning of June.

It was agreed that at the next meetings evidence should be produced upon the whole subject of verification and inspection of weights and measures, so as to enable the Commission fully to consider the whole question and to come to a decision not only upon this subject, but also upon that of the abolition of Troy weight, when they meet together again after the recess.

The next meeting of the Commission was fixed for Saturday, June 5th, at 11 A.M.

Adjourned at 3.30 P.M.

COLCHESTER.

THIRTEENTH MEETING.—WEDNESDAY, 16th JUNE 1869, at 1.30 p.m.

13TH MEETING, 16 June 1869.

PRESENT:

Lord Colchester (in the Chair).
Right Hon. S. Cave, M.P.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

At the request of the Astronomer Royal, Lord Colchester again took the chair.

After some verbal corrections in the minutes of the twelfth meeting, they were confirmed by the Commission, and signed by the Chairman.

A memorandum of the Astronomer Royal, on the state of the question now before them regarding the abolition of troy weight, copies of which had been distributed, was formally laid before the Commission; together with corrected printed proofs of the evidence taken at the twelfth meeting, and of Paper XVII.-II.

The Warden read a communication from the Astronomer Royal, stating that he thought it desirable that further evidence of—say four practical silversmiths and dealers should be taken on the subject of his suggested scheme for making avoirdupois weight available for their purposes, on the abolition of troy weight; and that this subject might be resumed when he was able to attend at the Commission.

A number of specimens of various weights, measures, and balances were exhibited to the Commission, including a box from Paris, sent by Mr. Fowler, containing models of metric weights, measures, scales, &c., officially stamped, and adopted by the French Governmennt for the use of schools.

The following witnesses were examined, principally upon the construction, &c. of weights, measures, and balances, viz.:—

Mr. H. Skinner, of the firm of Webb and Skinner, scale, weight, &c. makers, 185, Union Street, Southwark.

Mr. W. C. Fowler, of the firm of Nicholl and Fowler, scale, weight, and measure makers, 16, Aldersgate Street, City of London.

The next meeting of the Commission was fixed for Wednesday, 23rd June, at 1.30 p.m., when the examination of Mr. Fowler will be resumed, and that of Mr. Short, of the firm of De Grave and Co., proceeded with,

The Commission adjourned at 5.15 p.m.

COLCHESTER.

FOURTEENTH MEETING.—WEDNESDAY, 23rd JUNE 1869, at 1.30 p.m.

14TH MEETING, 23 June 1869.

PRESENT:

Lord Colchester (in the Chair).
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

The minutes of the thirteenth meeting were confirmed.

Proofs of a supplementary memorandum of the Astronomer Royal on the abolition of troy weight, and of the

14TH MEETING, 23 June 1869.

evidence heard at the last meeting of the Commission, were laid before the meeting.

The Warden of the Standards read a translation of a letter he had received from Dr. Von Steinheil, of Munich, in reply to an application to be furnished with copies of his glass metre and bergcrystal kilogram. A verified copy of the glass metre would be furnished to the Standards Department by Steinheil as soon as its coefficient of expansion had been determined with sufficient accuracy. But he was unable to supply a copy of his crystal kilogram, as he found it impossible to obtain at Munich a sufficiently large piece of rock crystal out of which he could construct a kilogram for the Standards Department; but he could supply a crystal *half* kilogram.

At the suggestion of Professor W. Miller, who thought a kilogram was far preferable to a half kilogram, it was decided that the Warden should endeavour to procure (perhaps through Messrs. Troughton and Simms) a piece of crystal of sufficient size, to be forwarded to Steinheil for the purpose of constructing a kilogram.

The following witnesses were examined upon the construction of standards and commercial weights and measures:

Mr. W. C. Fowler was further examined.

Mr. S. Short, of the firm of Messrs. De Grave and Co., scale, weight, and measure makers, of 59, St. Martin-le-Grand.

It was arranged that Wednesday next, the 30th inst., at 1.30, would be a convenient day for the next meeting, when the examination of inspectors of weights and measures would be proceeded with.

The meeting adjourned at 5 p.m.

COLCHESTER.

15TH MEETING, 30 June 1869.

Fifteenth Meeting.—Wednesday, 30th June 1869, at 1.30 p.m.

PRESENT:

The Lord Colchester (in the Chair).
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

The minutes of the fourteenth meeting were confirmed.

The Warden read to the meeting the draft of his third Annual Report to the Board of Trade, to be presented to Parliament in pursuance of the Act 29 & 30 Vict. c. 82. The meeting approved of the report.

The Parliamentary Return (No. 170, of 1869) of persons convicted of using false weights, measures, &c. was laid before the Commission.

It was reported to the meeting that the still recommended by the Commission, at the fourth meeting, to be provided for the use of the Standards Department, had been completed, and was now ready for use.

As to further evidence to be taken on the present system of inspection of weights and measures, the Warden explained to the meeting that it was proposed to hear first the evidence of the principal inspectors of weights and measures in the Metropolitan district, and afterwards some of the provincial inspectors would be selected to give evidence.

The following witnesses were then examined:—

Mr. Edward Ledger, Inspector, West District, City of London.

Mr. Edward Morrison, Inspector, No. 3 District, County of Middlesex.

The next meeting of the Commission was fixed for Wednesday next, July 7th, at 1.30 p.m., when the further examination of Mr. Short and of other witnesses on the present system of inspection will be proceeded with.

The meeting adjourned at 5.15 p.m.

COLCHESTER.

16TH MEETING, 7 July 1869.

Sixteenth Meeting.—Wednesday, 7th July 1869, at 1.30 p.m.

PRESENT:

The Lord Colchester (in the Chair).
The Astronomer Royal.
Sir J. G. S. Lefevre, K.C.B.
The President of the Royal Society.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

By the desire of the Astronomer Royal, Lord Colchester again took the chair.

The minutes of the fifteenth meeting were confirmed by the Commission, and signed by the Chairman.

16TH MEETING, 7 July 1869.

The corrected printed minutes of the evidence taken at the twelfth, thirteenth, and fourteenth meetings were laid before the Commission.

The Warden submitted to the Commission a paper, entitled "Observations on the spelling and pronunciation "of the names of Metric Weights and Measures," by Prof. E. Butler, of the National Education Office, Dublin, which had been transmitted to him by Mr. Yates. The Warden stated that he considered the spelling of metric terms to have been settled in the Appendix to the Metric Act, 1864, and that there was now no question of their pronunciation. The opinion of the Commission upon the nomenclature of metric weights and measures has also been given in their Second Report.

The Commission concurred in this view.

A letter addressed to the Chairman by Mr. Robert Shaw, of Bristol, forwarding a copy of a paper on the metric system, together with the Secretary's acknowledgment, were also read. The Commission did not consider that this paper required their particular consideration, as it contained only well-known arguments against the metric system and the decimal scale.

The Warden referred to the Parliamentary Paper, No. 170, of 1869, being a return of persons convicted in Great Britain during the quarter ended 24th June 1868, for using false weights, &c., copies of which had been recently distributed to the Commission.

Specimens of standard weights and measures used up to this time by the inspector of the borough of Wigan, and which had not been officially re-verified since 1835, were exhibited to the meeting; the weights had been coarsely adjusted with common soft solder by the inspector, and all these local standards were in a very dirty, battered state.

Two specimens of rock crystal were exhibited, which had been forwarded through Mr. James Simms, as specimens of the kind of crystal which might be sent to Dr. von Steinheil for the construction of a kilogram.

After some discussion on the present system of inspection, the following witnesses were examined:—

Mr. Short (further examination).

Mr. Daws, inspector of Newington district, county of Surrey.

Mr. C. W. Blythe, stamper of weights and measures, Guildhall, City of London.

Wednesday next, the 14th inst., at 1.30 p.m., was fixed for the next meeting of the Commission, when the evidence of other witnesses would be given.

The Commission adjourned at 5.45 p.m.

COLCHESTER.

Seventeenth Meeting.—Wednesday, 14th July 1869, at 1.30 p.m.

17TH MEETIN 14 July 1

PRESENT:

The Lord Colchester (in the Chair).
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

A letter from the Astronomer Royal was read regretting that he was prevented by illness from attending.

The printed minutes of the sixteenth meeting were read and confirmed.

The Warden explained the cause of the delay in the delivery of the Second Report of the Commission and Appendix, stating that he had found upon inquiry that according to the regulations of the Stationery Office the order to the Queen's Printers to print and deliver the copies of the Report had been withheld until it had been presented to Parliament; but upon representing that it was impossible for him to send any copies for presentation until they were first printed and delivered to him, the Controller of Stationery had now promised that an instalment of fourteen copies should be at once delivered for present use.

A letter from Capt. Forrest, Chief Constable of Hampshire, published in yesterday's *Times*, was brought under the notice of the Commission by the Warden. It was stated by Capt. Forrest that the inspection of weights and measures in the county was virtually suspended during the quarter ended 30th June 1868, owing to the delay in the Standards Department in reverifying the Hampshire standards. The fact was that these standards were delivered at the office with several other sets on 9th April, and were returned duly reverified on 17th April, many of them having been in the meantime sent back for readjustment.

The Warden read a reply to this effect, and commenting on other parts of Captain Forrest's letter. He proposed,

17TH MEETING, 14 July 1869.

with the sanction of the Commission and the Board of Trade, to send it to *The Times* for publication.

The Commission thought the letter required notice, and approved of the reply.

With regard to the question of verifying measures of capacity by ascertaining their depths and diameters by means of a gauge, the Warden submitted to the Commission a gauging rod which had been sent him by the Astronomer Royal, and also read a letter on the subject from Mr. Hoare, author of the "Sliding Rule." This matter was left for future consideration at a meeting when the Astronomer Royal should be present.

It was arranged that 11 o'clock on Wednesdays would be a more convenient hour for future meetings.

The Warden mentioned that he had received a letter from the Astronomer Royal approving of the printed proof of his Third Annual Report, and expressing his opinion that the departmental thermometers and barometers should be tested at Greenwich, as well as at Kew. The Warden explained that in having these instruments reverified at Kew, he had acted under the sanction of the Commission, as stated in the last paragraph of the Minutes of the Seventh Meeting. The Astronomer Royal also considered that with reference to the Gas Measuring Standards it might be desirable that an air thermometer should be constructed for the use of the Standards Department.

The President of the Royal Society said that the Kew Observatory possessed the requisite instruments for the most accurate verification of thermometers and barometers. It was agreed that it would be desirable to leave the consideration of both these subjects until the Astronomer Royal should be present.

The following witnesses were examined on the present system of Inspection of Weights and Measures:,

Mr. J. Strugnell, inspector of A. West district, county of Surrey,

Mr. R. Mellor, chief inspector, Manchester.

The next meeting of the Commission was fixed for Wednesday next at 11 a.m.

The Commission adjourned at 5.45 p.m.

G. B. Airy,
Chairman.

18TH MEETING, 21 July 1869.

Eighteenth Meeting. — Wednesday, 21st July 1869, at 11 a.m.

The Astronomer Royal (Chairman).
The Lord Colchester.
The President of the Royal Society.
The Master of the Mint.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The minutes of the seventeenth meeting were read and confirmed.

2. The Warden stated that he had received some copies of the Second Report of the Commission, and the Appendix complete, from the Queen's printers on 16th July, and that one copy was sent immediately to each member of the Commission, and three copies were sent to the Home Office, with a letter from the Secretary, in order that one copy might be presented to Her Majesty, and one copy to each House of Parliament. In his letter, Mr. Chaney referred to the Chairman's letter to the Home Secretary, of 1 May last, transmitting the signed copy of the Second Report; and he has received to-day a reply from the Home Office, stating that the Report had been laid before the Queen. It appears from the minutes and votes of the two Houses of Parliament, that the Second Report was presented by command on the 20th instant.

3. The printed Minutes of Evidence on 7th July were laid before the Commission, and proofs of the evidence on 14th July.

4. The Warden read a paragraph relating to the verification of the departmental thermometers at the Royal Observatory, Greenwich, which he had submitted to the Astronomer Royal, and proposed to insert in his Third Annual Report to the Board of Trade.

5. Copies of the Pharmaceutical Journal, for May and June 1869, containing a paper by Dr. Redwood on the introduction of metric weights and measures for use in Pharmacy, in which reference was made to the paper delivered by the Master of the Mint to the Standards Commission, on the abolition of troy weight, together with a discussion thereon, were laid before the meeting by the Warden.

6. The Warden also read a letter from Mr. J. Simms, relating to the two pieces of crystal forwarded to the Standards Department, with a view to their transmission to Dr. von Steinheil. It was left to Professor Miller and the Warden to determine whether the crystal was sufficient for the purpose of constructing a Kilogram, and to deal with the matter.

7. Two new standard thermometers made and verified at Kew Observatory, and presented to the Standards Department by the Kew Committee, were exhibited to the Commission.

8. The Warden also exhibited an old French weight, of latten, in the form of a series of cup weights in a closed box of the same metal, and weighing altogether 8 lbs. of the old poids de marc, which had been presented to the Standards office by Col. Le Couteur, Viscount of Jersey. It is of elegant form, and has some ornamental engraving upon it.

9. The new set of standard avoirdupois weights constructed by Mr. Oertling, including the new 10 lbs. standard, and the re-adjusted 10 lbs. standard weight, originally verified by Professor Miller, and the standard weights of 62·321 lbs. were exhibited to the Commission.

10. The Warden referred to some correspondence between the Astronomer Royal, Professor Miller, and himself, on the expediency of the Standards office being supplied with several accurately verified copies of the units of imperial and metric weight, the pound and kilogram, as auxiliary standards to be used in the verification of the several official standard weights, which are multiples of those units. And he accordingly proposed to direct Mr. Oertling to construct 14 copies of the Imperial standard pound, and ten copies of the kilogram, to be made of Baily's metal, not gilt, and similar in form to the new set of avoirdupois standard weights. These weights would be distinguished by numbers. The Commission concurred in this proposal.

11. He also referred to the question of the construction of an air thermometer for the use of the Standards office, not to give temperature comparable with that of other thermometers, but to give expansion of air, which may be considered as identical with expansion of gas, and be serviceable in the comparison of gas-measuring standards. He had been in communication with Professor Rijke, of Leyden, and with the President of the Royal Society, and the Astronomer Royal, upon this subject, and had inspected a partly constructed air thermometer at the Kew Observatory. The Commisssion considered it to be desirable that an air thermometer should be supplied for the Standards Department and it was left with the Warden to make the necessary arrangements with the President of the Royal Society, who was requested to superintend the construction of an air thermometer at Kew Observatory.

12. With reference to the verification of the departmental thermometers, the Chairman stated that for the future it would be desirable to have them tested at the Royal Observatory, Greenwich, and at the Kew Observatory.

13. The Warden stated that it was very desirable for the Standards Department to be provided with a cathetometer for accurately noting the height of the barometer, and that he had taken steps for procuring proper thermometers to be attached to each barometer, for ascertaining the temperature of the mercury in the tubes. The Commission concurred and left it to the Warden to obtain a proper cathetometer from Messrs. Troughton and Simms.

14. The report of a Commission of the Imperial Academy of St. Petersburgh, on the constructiom of primary International Standards of the Metric system, drawn up by M. Jacobi, was laid before the Commission by Professor Miller. It was considered that no action of the Standards Commission was now required, but that it was a matter for the consideration in the first instance of the executive Government. The Warden explained that he proposed to mention this important paper in his Third Annual Report.

15. The Chairman read a letter from Mr. Yates to the Warden, pointing out what he considered an important mis-statement in § 10 of the Second Report of the Commission, "that not one shopkeeper was among the witnesses " examined by the House of Commons Committee in 1862," and calling attention to the evidence of Matthew Wood, who kept a grocer's shop. The Chairman explained that the evidence showed Mr. Wood to be a *wholesale* grocer, having large foreign transactions, and he therefore did not consider him to be a mere shopkeeper. The Warden was requested to write to Mr. Yates to this effect.

16. The following witnesses were examined upon the subject of the present system of inspection of weights and measures:—

Mr. T. E. Gibb, vestry clerk, St. Pancras.
Capt. W. C. Harris, Assistant Commissioner Metropolitan Police.
Mr. R. Mellor (further examination).

18TH MEETING, 21 July 1869.

17. Wednesday next at 11 a.m. was fixed for the next meeting of the Commission, when further evidence would be given on the subject of inspection.

18. With reference to future meetings, and the further evidence to be taken on the present system of inspection, the Commission were of opinion that some other witnesses should be requested to give evidence on behalf of the magistrates, and of the police, as well as the inspectors-general of constabulary for Ireland and Scotland. The Warden thought that as it was proposed to transfer the metropolitan inspection from the Middlesex magistrates to the police, it would be also desirable to have the evidence of one of the Middlesex magistrates.

Adjourned at 3 p.m.

G. B. AIRY,
Chairman.

19TH MEETING, 28 July 1869.

NINETEENTH MEETING. — WEDNESDAY, 28th JULY 1869, at 11 a.m.

PRESENT:

The Astronomer Royal (Chairman).
The Lord Colchester.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The minutes of the eighteenth meeting were confirmed.

2. With reference to Mr. Yates' letter of the 16th inst., referred to in s. 15 of the minutes of the last meeting, the Warden read a copy of his reply to Mr. Yates, to the effect there stated. Lord Colchester mentioned that he had made a similar statement in the House of Lords yesterday in reply to Earl Fortesque.

3. Lord Colchester laid before the meeting a letter he had received from Mr. Bonn respecting his proposed new "Albert" system of weights and measures. The Warden said that he also had received a letter from Mr. Bonn requesting an interview with him in order that he might be allowed to explain his system. The Chairman considered that it would be sufficient for Lord Colchester to acknowledge the receipt of Mr. Bonn's letter, and to state it had been laid before the Commission.

4. The Chairman read a letter from Colonel Le Couteur, describing the ancient weight referred to in s. 8 of the Minutes of the last meeting, and presenting it to the Commission to be deposited in the Standards Department.

5. The subject of the amount of expenses of witnesses for attendance on the Commission was considered by the meeting, and with reference to a separate charge of three guineas a day for attendance sent in by Mr. Mellor, the Chairman read the scale of subsistence-allowances to witnesses, in addition to travelling expenses, as stated in the Treasury letter of 9th July 1868, and requested the Warden to write to Mr. Mellor for further explanation as to this charge.

6. As to the two pieces of crystal for the construction of a standard kilogram, the Warden stated it had been found by experiment that the larger piece only was of sufficient size. The Commission were therefore of opinion that the Warden should take the necessary steps for purchasing the larger piece, and transmitting it to Dr. Von Steinheil, in order that the new standard kilogram should be constructed from it.

7. Two letters, dated 16th May, 1869 and 27th July 1869, from Captain Martin Roberts, a magistrate of the counties of Brecon and Monmouth, were read to the meeting. These letters referred to the method of inspection in counties, and to the necessity for providing against fraudulently selling articles of false weight or measure.

8. The following witnesses were examined:—

Martyn Roberts, Esq., magistrate, county of Brecon.
E. Cresy, Esq., of the Metropolitan Board of Works.

9. As to any further evidence, the meeting concurred with the Warden that it would be desirable to complete the evidence upon the subject of inspection of weights and measures before the vacation; and that for this purpose it would be sufficient that the following witnesses should be requested to attend at the next meeting of the Commission:—

The Chairman of the Bench of Middlesex Magistrates.
Sir Thomas Tilson, Chairman of Quarter Sessions, Surrey.
Colonel Stewart Wood, Inspector General of the Royal Irish Constabulary.

As the system of inspection in Scotland was generally carried out by the constabulary, it was upon consideration not deemed requisite to hear evidence from Scotland, as ample evidence on the police inspection had already been given.

Further evidence on the proposed abolition of Troy weight would be heard after the recess.

10. The Warden called the attention of the Commission to an improved apparatus for comparing cubic foot measures now used by the Metropolis Gas Referees, as well as to the standard photometer or apparatus for measuring the illuminating power of gas, to which is attached a very accurate experimental gas meter and gas governor, in order that the Commission might consider whether it was desirable that similar apparatus should be supplied for the Standards Department. The price of this apparatus made by Mr. W. Sugg is as follows:—

	£	s.	d.
Cubic foot measuring apparatus, complete	40	0	0
Standard photometer - - -	15	15	0
Experimental meter - - -	10	10	0
Gas governor - - - -	4	4	0
	70	9	0

He suggested that it would be more satisfactory if these instruments, which were now in the office of the Gas Referees, in New Street, Spring Gardens, were first inspected by the Commission. This subject was left for consideration at the next meeting, when the Commission might be able to inspect the apparatus in question.

11. The Commission then inspected the gas-measuring room of the Standards Department, and the two small rooms beyond it, now occupied by the office-keeper as bedrooms. Considering the increased and increasing business and apparatus of the Standards Office, and the inadequate accommodation now afforded, as well as the great inconvenience of there being no access for the office-keeper and his family to these two bedrooms, except through the gas-measuring room, the Commission considered that it was most desirable that these two small rooms should be thrown into one, and appropriated for the additional standards apparatus now being supplied, and that sleeping accommodation should be afforded to the office-keeper in the rooms on the upper floor of the house 7, Old Palace Yard, which are now vacant. The intermediate rooms on the second floor, also now vacant, will in all probability very shortly be required for the purposes of the Standard Office, and it was recommended that these rooms should at the same time be reserved for this purpose. They considered also that the two vacant rooms in the basement of the Norman tower, to which a staircase leads from the passage of the gas-measuring room, would be very convenient as store-rooms or other official purposes, for the department, and they recommended that the Warden should make the necessary application to the Office of Works to secure this additional accommodation, by which the whole of the house, No. 7, Old Palace Yard, would be appropriated to the Standards Office. It was obviously of importance that, so far as respects any persons unconnected with the Department, there should be no means whatever of access to, or interference with, the rooms where the large and valuable collections of standards and apparatus is deposited.

12. The members of the Commission then accompanied Mr. Cresy to the office of the inspector of Gas Meters in St. Ann Street, Westminster, to see all the arrangements of the office, and to inspect the copies of the gas-measuring standards and other apparatus in use. They expressed their satisfaction with the arrangements made there.

13. It was suggested by the Warden that it might be desirable that the Commission should also inspect the offices of one of the inspectors of weights and measures, to see the arrangements for the custody of the standards and apparatus, and the accommodation which was afforded for the performance of the duties. This was left for a future occasion.

14. The next meeting of the Commission being fixed for Wednesday, 11th August, at 11 a.m., the Commission adjourned at 3 p.m.

G. B. AIRY,
Chairman.

20TH MEETING, 11 Aug. 1869.

TWENTIETH MEETING.—WEDNESDAY, 11th AUGUST 1869, at 11 a.m.

PRESENT:

The Astronomer Royal (Chairman).
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The minutes of the nineteenth meeting were confirmed.

2. The printed minutes of evidence up to and including 28th July 1869, were furnished to the Commission.

3. The Warden laid before the Commission a copy of an Act passed by the New Zealand legislature, dated 16th October 1868, for consolidating and amending the laws

20th Meeting, 11 Aug. 1869.

relating to weights and measures. This Act had been brought under his notice by Messrs. De Grave & Co., who had been instructed by the New Zealand Government to submit a number of standard weights and measures for that colony, of the denominations mentioned in the schedules, for comparison and verification at the Standards Office.

The Chairman read an abstract of the Act, made by the Warden, who pointed out that one of the stated standard weights was an 8 oz. troy weight, of which there was no official standard.

The Commission were of opinion that in this special instance of verifying primary standards for a Colonial Government, the Warden should comply with the application of the New Zealand Government by comparing the New Zealand 8 oz. troy weight with the official 6 oz. and 2 oz. troy standards.

The Chairman remarked that the Act contained several new provisions which it might be desirable for the Commission to consider hereafter, with a view of their being embodied in the resolutions suggested for improving the present system of inspection, upon their revision by the Warden.

4. A letter from General Morin to the Warden was read by the Chairman, in reply to the application for copies of the French metric standards and apparatus, and suggesting the construction of a new platinum kilogram, instead of a brass kilogram for the Standards Office.

The Commission considered that no better evidence of the standard weight of the primary platinum kilogramme des Archives was required for the Standards Department than that afforded by the platinum kilogram and the gilt gun-metal kilogram, now deposited there, both of which had been most accurately verified by Professor Miller.

The Warden was consequently instructed to apply to General Morin for a verified copy of the kilogramme en laiton doré, referred to by General Morin.

5. The Warden laid before the Commission the result of the official comparison and reverification recently made of the auxiliary gilt gun-metal kilogram 𝔎 with the platinum kilogram 𝔈, showing that, with reference to the original verification by Professor Miller in 1844, 𝔎 had apparently gained in weight since 1844, as compared with 𝔈, 13·377 milligram or 0·20643 grain.

Professor Miller remarked, with respect to the apparent gain of weight, both in the gilt gun-metal standard 10 lbs. and in the gilt gun-metal kilogram, that Barrow, who made some of the first gilt gun-metal avoirdupois standard pounds, had come to the conclusion that electro gilding was worthless; and he added that his own faith in its superiority to the ordinary method of gilding by amalgam was much shaken.

A memorandum made by Mr. Chaney was read, stating that on the surface of both the gilt metal 10 lbs. standard and the gilt gun-metal kilogram, when viewed through a magnifying glass, there appeared to be a number of small holes or cavities in the gilding, attributable to the crystalline coat of gold deposited. He considered that these admitted air to the encased gun metal, thus causing oxydation, and in course of time also they would become filled with dirt.

It was agreed that the question of the use of gilt gun-metal standard weights should be left for future consideration, when the Warden's paper upon the comparisons of these kilograms should be printed.

6. The Chairman read the translation of a letter from Professor Starke, of the Polytechnic Institute, Vienna, to the Warden, in reply to the application for a copy of the Austrian standard klafter, and stating that only the mechanical construction of the copy would be executed by him, and that application for its verification should be made to Dr. T. Herr, Professor of Higher Geodesy at the Polytechnic, in whose charge the Austrian standard was placed. The Warden was requested to communicate accordingly with Professor Herr.

7. With reference to Mr. Bonn's so-called "duodecimal and decimal Albert system of weights and measures," which he had endeavoured to bring under the notice of the Board of Trade and the Commission, the Warden said that Mr. Bonn had called upon him to explain his system, and had produced many elaborate papers and diagrams for that purpose, upon which a vast amount of care and labour had been expended. So far as he could understand Mr. Bonn's plan, it appeared to be based upon a new fundamental unit of length of 4 feet, and to be elaborately carried out upon the plan of the metric system, as regards other measures and weights, based upon this unit, and a decimal scale; that this unit of 4 feet was selected as agreeing with four farthings in a penny, and his duodecimal scale was formed with a view to an agreement in the respective weights and measures and prices in shillings; and that although this unit purported to be the ten-millionth part of the quadrant of a "new astronomical meridian," it was simply that of the quadrant of an imaginary sphere, of the size of the earth overlaid with a sufficient thickness of atmosphere!

8. The Warden stated that he had given directions for the large air pump in the Standards Office to be put in order by Messrs. Troughton and Simms, so that it might be available for use. The Commission concurred in the propriety of this being done.

9. As to the expenses for attendance charged by Mr. Mellor, the Warden read his letter to Mr. Mellor, as instructed by the Commission at the last meeting, and Mr. Mellor's reply explaining the circumstances under which he made his charge. A list of expenses allowed by Select Committees of the House of Commons was also put in. The Commission concurred in the Chairman's opinion, that the scale of allowance of 1*l*. for each night absent from home for hotel expenses, was all that could fairly be sanctioned by them, without any further allowance to Mr. Mellor for attendance. The secretary to write to this effect to Mr. Mellor.

10. A note from Messrs. Tylor to the Warden was read, stating that upon further consideration he thought the revolving drill for engraving, to which he had called attention, would not suit the purposes of the Standards Office. Professor Miller undertook to obtain some further information respecting [Grubb's engraving apparatus, and would communicate with the Warden upon the subject.

11. The Warden called attention to the reports in the Pharmaceutical Journal of May and June last, of an important discussion at the Pharmaceutical Society upon the subject of the proposed use of metric weights and measures in pharmacy, brought forward in a paper read by Dr. Redwood.

12. The following witnesses were examined, to complete the evidence required by the Commission upon the subject of the inspection of weights and measures:—

- J. F. Pownall, Esq., Chairman of the Holborn Division of the Middlesex Magistrates.
- Sir T. Tilson, Chairman of the Quarter Sessions, Surrey.
- Mr. R. Harvey, Sub-inspector, Royal Irish Constabulary, and Inspector of Weights and Measures, County Antrim.

13. The Commission then visited the office of the Sealer and Inspector of weights and measures for the city and liberty of Westminster, which is in a vault under part of the Court House. They were received by the inspector Mr. W. C. Bussell, who is also the sealer. Although the essential points of the state of the local standards and apparatus, and the method of conducting the business (excepting the mode in which the measurement by rape seed is carried out), appeared to them satisfactory, the accommodation afforded by this vault was found to be wholly inadequate for the purpose, and quite unworthy of its character as an office for testing the weights and measures of so important a metropolitan and trading district as the city of Westminster.

14. The Commission next inspected the photometers and other gas-measuring apparatus, including an improved mode of filling a standard cubic foot bottle with water, and thus displacing a cubic foot of air, made by Mr. W. Sugg, at the office of the Metropolis Gas Referees, in New Street, Spring Gardens. The several instruments, which are described in a Report to the Board of Trade, laid before Parliament by command of Her Majesty in June 1869, were explained to them by Mr. F. J. Evans, one of the Gas Referees.

The consideration of the question how far it was expedient that any similar instruments should be supplied to the Standards Department, was left for future consideration.

15. The period of the reassembling of the Commission after the recess was left for the decision of the Chairman, after the requisite communications from the Warden of the Standards, as to the progress of business, shall have been made to him.

The Commission adjourned to 4.30 p.m.

G. B. Airy,
Chairman.

Twenty-first Meeting.—19th November 1869, at 11 a.m.

21st Meeting, 19 Nov. 1869.

PRESENT:

The Astronomer Royal (Chairman).
The Lord Colchester.
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

A letter from Sir John S. Lefevre was read, regretting that illness prevented his attendance.

21st Meeting, 19 Nov. 1869.

The Warden of the Standards stated that he feared the Commission would for some time be deprived of the valuable assistance of Mr. Cave, as he was informed that he had gone abroad for the winter to recruit his health.

1. The Chairman referred to the lamented death on 16th September last of the Master of the Mint, and to the consequent great loss sustained by the Commission, particularly at the present time when the subjects of the abolition of troy weight, the introduction of metric weights, and the proposed International Commission were under consideration.

2. The minutes of the 20th meeting were confirmed.

3. A copy of the Chairman's non-official communication to the Deputy High Steward of Westminster, respecting the state of the office of the Inspector of weights and measures for Westminster, was read, together with the reply of the Deputy High Steward.

4. The Warden laid before the Commission printed copies of—

- Papers relating to the proposed International Standards Commission at Paris;
- Paper III.–v., containing further cases illustrating the working of the weights and measures laws;
- Paper III.–vi. (in part), containing also correspondence relating to the inspection of weights and measures used by officers of the Post Office, Customs, and Excise departments.

5. As to the proposed Third Report of the Commission upon the abolition of troy weight and substitution of metric or avoirdupois weight,

Reference being made to the speech of the Chancellor of the Exchequer on 6th August 1869, upon the subject of the gold coinage, and the alteration of weight of fine gold in the sovereign, the Chairman said that so far as it related to the question of an international coinage, it did not concern the Standards Commission. He read a letter from Mr. Thomson Hankey, deprecating the suggested alteration of the weight of the sovereign to 8 grams, and the consequent slight change of standard of fineness, and urging that any alteration of the standard should rather be from $\frac{11}{12}$ to $\frac{9}{10}$.

Professor Miller thought it very desirable to have the same standard of fineness as in France. He had understood from the late Master of the Mint that an alloy of $\frac{9}{10}$ was found to continue tolerably constant even after successive meltings of the alloyed metal.

The Warden of the Standards said he proposed to lay before the Commission the mode in which the weight of the sovereign and its alloy would be affected by the proposal of the Chancellor of the Exchequer, as well as some other statements upon the subject, as affording useful information for arriving at a practical solution at a future time of the whole question of the weight and standard of fineness of the gold coinage. This question involved other considerations than could be dealt with by the Standards Commission, and it was evidently advisable that a slight alteration of the weight of the sovereign or of its standard of fineness should not at the present time be recommended by the Commission.

With respect to further witnesses to be heard upon the question of the abolition of troy weight and proposed substitution of avoirdupois or metric weight, the Chairman said he was of opinion that evidence was desirable as to the actual practice of dealers in gold and silver plate, in the use of weights for buying and selling as between retail dealers and the public in open sale. It was this which principally demanded the consideration of the Commission, as affecting the interests of the public, and especially the poorer classes, who required the protection of the law. Transactions between wholesale and retail dealers, as well as between masters and their workmen, were of a different character and more of a private nature, in which the two parties could take care of their own interests.

The Warden of the Standards observed that this distinction was clearly pointed out in the existing law, the inspection being applicable only to weights and measures used in shops and other places where goods are exposed or kept for sale. He read a letter from Mr. Willoughby, dealer in gold and silver plate, at Windsor, containing some information on the points mentioned, and showing that a charge was made by wholesale dealers for the precious metal per oz., and an additional charge for workmanship.

Professor Miller said that it was a custom in some of the London houses to charge for workmanship of the silver by the weight.

It was considered by the Commission that it would be sufficient to have the evidence of Mr. Willoughby, and of a wholesale dealer from Birmingham, at their next meeting.

21st Meeting, 19 Nov. 1869.

6. As to the progress towards the proposed Fourth Report upon the system of inspection of weights and measures in the United Kingdom, the Warden of the Standards said that the paper XIV.–1 was in a state of forwardness, but that its completion was delayed until further information had been obtained, 1st, on the subject of the inspection of Post Office, Customs, and Excise weights and measures, and, 2nd, on that of the inspection of gas meters. The latter was of the more importance as little evidence had been as yet laid before the Commission upon the working of the Sale of Gas Act of 1859. He had already collected some information from persons practically acquainted with the subject, and was daily expecting to be furnished with more, which the Commission would probably think of importance.

7. With respect to the proposed Fifth Report of the Commission upon the reverification of the official standards of the Board of Trade, and verification of new standards, and on the business of the Standards Department, the Warden exhibited the new commercial standard of length, with attached apparatus, which had just been completed and delivered by Messrs. Troughton and Simms, and the new metric standard kilogram and litre from Paris. The reverification of the remaining official standards and the verification of the new standards were progressing rapidly and were far advanced.

8. The Warden said that the printing of the several appendices to the Third, Fourth, and Fifth Reports of the Commission, the greater part of which was now ready for the printer, would take a considerable time, and it would be desirable that it should be proceeded with at once in order that the issue of the Reports, when agreed to, should not be delayed. The Queen's Printers had informed him that it would be very convenient if they could go on with it now, when there was no pressure of Parliamentary work.

The Chairman was of opinion that the printing of these appendices should be at once begun, and the necessary directions given.

9. The Warden next called attention to the result of the reverification of the standard cubic foot measure as deserving the consideration of the Commission. Having been compared with the same bullion standards which had been used for verifying the standard 62·321 lbs., the legal weight of a cubic foot of water, it was found from weighing its contents of distilled water, after allowing for the necessary correction to the temperature of 62° Fahr., and barometric pressure of 30 inches—

		Grains.	
Oct. 20.	Contents of standard cubic foot - - - -	114·79019	too heavy.
Oct. 22.	Contents of standard cubic foot - - - -	115·65778	„
	Mean - -	115·22398	

The close accordance of these two weighings was very satisfactory. He proposed however further to test the standard measure by weighing it against the standard 62·321 lbs. weight.

In the meantime, the question of the accuracy of the legal weight of a cubic foot of water, viz., 62·321 lbs. was of more importance, and he had shown, in Appendix VI. to the Second Report of the Commission, that according to the more recent determination of Kupffer the true weight was 62·2904 lbs., being less by 214·2 grains than the present legal weight as determined in 1798 by Sir George Shuckburgh. He exhibited to the Commission the mode of determination by Shuckburgh (afterwards confirmed by Kater), as well as that by Kupffer, together with drawings of the measuring apparatus used by Kupffer, and he suggested the expediency of a new and accurate determination of the weight of a cubic foot of water by direct observations instead of basing this fundamental weight, as at present, upon the determination of a cubic inch of water. This question had already been referred to at the eleventh meeting of the Commission, and its solution considered desirable. With this object he had procured from Messrs. Troughton and Simms estimates of the cost of a new measuring apparatus, similar to that used by Kupffer, as well as of a metallic cylinder or cube to be accurately measured, and the weight of water displaced by it ascertained. These estimates would be laid before the Commission.

Professor Miller considered that the distilled water used in the experiments by Sir George Shuckburgh was not sufficiently pure, either when fresh procured from St. George's Hospital, or after being kept for some time without proper means of preventing its deterioration. He referred to the measurement of a cubic inch of water by

21st Meeting, 19 Nov. 1869.

Stampfer, by the use of a cylinder 3 inches in diameter and height; this was too small. He strongly recommended a solid body capable of displacing at least 62 lbs. of water, and thought a glass cylinder might be preferable. The flat surfaces of a hollow cube would be very likely to yield to pressure.

The Chairman thought a solid cube with planed sides would be better. The turning of a cylindrical body in a lathe with a horizontal axis was objectionable; if turned, it should be with a vertical axis.

Professor Miller concurred in this last opinion.

The Warden of the Standards said that he had consulted Mr. James Simms upon these points. Either a cubic or cylindrical body, solid or hollow, could be constructed, but probably a cylinder with greater accuracy. In the latter case, it might be useful to adopt the course employed in France, by marking the sides of the cylinder with horizontal and vertical lines at determinate intervals, and continuing these lines on the top and bottom of the cylinder, so that the vertical would become radial lines. Whether a cylinder or cube, and perhaps the best mode would be to use both, it was a great object to have the body of sufficient size to avoid the chance of multiplication of error, as in the determination of the weight of a cubic foot of water from the weight of a cubic inch. He had, therefore, suggested to Mr. J. Simms that the new measuring apparatus should take in at least a cubic foot. The apparatus would consist of two equal cylinders, each having a scale of 12 inches upon it, and one end with a pointed cone. These cylinders being placed in a horizontal line with the points towards each other and in contact, the scales would be read by means of two microscopes and noted, thus enabling the length of the distance between two opposite sides of a body, when placed between the points, to be accurately determined, by sliding the cylinders from each other, and reading the distance upon the scales.

The subject was left for further consideration, the Commission in the meantime approving of the necessary apparatus being obtained for the Standards Department.

10. The question of glass standard weights, as suggested by Mr. M. Roberts in his evidence, and deemed by Professor Miller deserving of consideration, was referred to by the Warden of the Standards. He had been in communication with Mr. Dowling, of Little Queen Street, Holborn, who made and sold spherical glass weights adjusted with lead, the glass being cast in a mould and having a conical hole in its vertical axis, where the lead is securely fixed; and with M. Salleron, of Paris, who had constructed metric weights of hollow glass of a spherical shape and adjusted with mercury, and then hermetically closed. He had ordered a set of each of these glass weights, which would, when received, be submitted to the inspection of the Commission.

The Chairman suggested the use of small shot as less expensive than mercury and answering the same purpose. With respect to the experiment of constructing standard weights of glass, he considered that plate glass was objectionable as it cannot be re-heated, and therefore must be made, in its first chemical composition, so soft that it may be at once formed in the requisite shape; but blown glass is made very hard and less liable to be affected by moisture.

Professor Miller agreed to the objection against plate glass, and thought that blown glass proper for the purpose, and which would not be injuriously affected by hydroscopic influences, might be obtained. He suggested that Messrs. Chance of Birmingham should be consulted for this purpose, and that Mr. Oertling should be placed in communication with them for constructing specimens of glass standard weights.

It was left to the Warden to take the necessary steps to carry out this suggestion, and to report further to the Commission.

11. The Warden called attention to some proceedings recently taken under the Petroleum Act by the Metropolitan Board of Works, in which a considerable discordance appeared in the result of testing of petroleum as directed by the Act, arising from a difference both of the construction of the apparatus and the mode of using it; thus tending to show the expediency of legalising a standard test apparatus, and authoritative official instructions for its use. It should be observed that the duty of inspecting petroleum is now by law thrown upon the Inspectors of weights and measures. Under the Act, any person having upon his premises petroleum giving out an inflammable vapour under 100° Fahrt. was liable to a penalty, it being considered as dangerous to the public. It appeared from the published report in the Times of 4th November 1869, that the petroleum was separately tested by the official inspector of petroleum under the authority of the Metropolitan Board of Works, and by the Secretary of the Petroleum Association, each having his own test apparatus, one showing the vapour to ignite at 95°, and the other at 105°; and the Magistrate after stating that the Act was a most important one for him to enforce, and the safety of the public was paramount to all other considerations, gave the doubt against the defendant, and fined him the full penalty, 20*l*. The barrister who conducted the defendant's case, said there would be an appeal to the Quarter Sessions.

21st Meeting, 19 Nov. 1869.

A testing apparatus used by Mr. Mills, the inspector of gas meters for Western Middlesex, was produced for the inspection of the Commission by the Warden, and its use explained. He stated also that one of the inspectors was close at hand, and would attend to give any explanation and show the action of the apparatus, if desired.

Professor Miller thought this a question for the consideration of the Board of Trade, but doubted whether the Commission should take it up.

The Chairman thought that it hardly came within the terms of the Commission, as it was more connected with chemistry than with weights and measures.

He ruled that for the present they would not entertain the question of establishing a standard apparatus for testing petroleum.

The Warden said that this was really a matter of some importance, and would have to be dealt with by some administrative authority, probably by the Board of Trade. The question of a standard test apparatus for petroleum was analogous to that of a standard gas burner, a standard photometer, as well as a standard alcoholmeter and saccharometer.

12. As to the question of a standard alcoholmeter, which was adopted both in France and Germany, precise instructions for their use being authoritatively drawn up, the Warden reminded the Commission that he had referred to them in the correspondence with the Secretary of the Customs, and of the Excise Department, contained in Paper III.–VI., and he exhibited to the Commission specimens of Syke's hydrometer, and a saccharometer, as used by the Excise, and constructed by Mr. Oertling, from whom he had procured them for this purpose.

The Chairman thought the question of a standard alcoholmeter was not within the province of the Commission.

13. The Warden read a letter from Dr. von Steinheil, stating that the smaller piece of rock crystal sent to him, proved on being cut to be well adapted for the construction of a kilogram. The larger piece was found to have too many flaws, and was accordingly sent back to the Standards Department. It had since been returned to the person from whom Mr. James Simms had originally procured it.

14. The subject of the proposed International Standards Commission at Paris was next considered. The Chairman referred to the report of the French Government of 1st September 1869, appointing the French members of the Commission, and to the first impression made upon M. Jacobi's mind, as well as his own, that the proposal was unsatisfactory to other countries adopting the metric system, either as a national or an international system of weights and measures, as it appeared to them that France wished to retain the regulation of the metric standards, and thus some national jealousy must be roused.

Professor Miller had certainly thought from the wording of the Report that it was merely intended to invite other countries to send delegates to the Commission, who would give the authority of their names to the results, without having any real control over the operations of the Commission, which would rest with the French members. This was the more unsatisfactory to him, as he considered some of the French instruments of verification, as well as their mode of verification, imperfect.

The Warden said he also had at first put the same interpretation upon the French Report. He then proceeded to explain what had since occurred whilst he was at Paris. He was present at the Séance of the French Academy, when M. de Jacobi brought the matter forward there, and read his paper, a printed copy of which had been sent to each member of the Commission. M. de Jacobi urged that the Commission at Paris should be a strictly international one, for the purpose of constructing and verifying a series of metric standards all of a primary and authoritative character, and that full and equal power should be given to all the members, whether French or foreign, over all the determinations and operations, including the material of the standards, and the instruments and methods

21st Meeting, 19 Nov. 1869.

employed. But no further steps were taken by M. de Jacobi, upon his being assured by General Morin, that it had been always intended to carry out the views which he had thus stated, and M. de Jacobi had since expressed himself as satisfied that this would be done.

The Warden added that he himself had frankly told General Morin, by whom the French Report had been drawn up, of the impression produced by it here. General Morin assured him that its contents had been misinterpreted; that it had from the first been intended that equal power should be given to all the members, and pointed out the following words in the Report as meant to express this intention;—" Il convient de provoquer de la part de toutes " les puissances que désiraient y participer, la co-opération " de savants chargés de prendre part à toutes les études, " et à toutes les résolutions propres à donner une confiance " entière dans l'exactitude des étalons secondaires, derivés " de nos étalons métriques des archives." He added that special care would be taken in the letter of invitation to Foreign Governments to send delegates to the Commission, that it should be worded so as to remove all doubt upon this point. In fact, the General read to him a draft of this letter which had been sometime drawn up, as evidence that this intention had been, from the very first, entertained.

A certified copy of the letter of invitation of the French Government, which had been subsequently given by General Morin to the Warden, was then read by him to the Commission. He added that it had been previously communicated to the Astronomer Royal, who had expressed his satisfaction at its contents, and that a report to this effect had also been made by him to the Board of Trade.

The Commission were of opinion that this explanation was quite satisfactory, and the Chairman said that he should propose a resolution for the purpose of expressing that opinion.

The Warden added some further explanations as to the French members of the Commission, who had been already appointed, as well as upon some other points, and said that General Morin had expressed to him in strong terms a hope that the Astronomer Royal would be appointed as a member from this country, and thus give them the valuable support of his counsel, experience, and reputation. He had himself also represented to the Astronomer Royal that it was due to his position, as the highest Standards authority in this country, that he should, if possible, take part in these important proceedings for practically establishing an international system of weights and measures; and that his attendance would be requisite only for the more important deliberations, as another member might give his attention to the detailed operations.

The President of the Royal Society concurred in this view, and thought it highly important that the Astronomer Royal should represent this country at the International Commission.

The Astronomer Royal said that his time was so entirely occupied he feared it would be impossible for him to attend at Paris. He might add that the Standards business already pressed hard upon him, and he found, on counting this morning, that not less than 110 letters had passed between him and the Warden of the Standards, since 1st January last. It was of much importance that this country should be properly represented at the Commission, and he had no doubt when the period arrived for nominating the members, due consideration would be given to their selection.

15. With regard to the verification of the metric standards for the Standards Department at the Conservatoire Impérial des Arts et Métiers at Paris, in which the Warden had recently taken part, he said that a statement of the several proceedings and their results would be laid in a printed form before the Commission. All the details would be fully stated, and would probably be found worthy of attention, from the fact of the operations of verification having been carried out more completely than might otherwise have been the case, as they were intended to be a rehearsal of the modes of verification, and of the use of the instruments that might be adopted by the International Standards Commission.

At the present time he would only have to call attention to some of the operations at the Conservatoire, with the view of submitting to the Commission whether the instruments used might not be advantageously adopted in the Standards Department, and in order that the necessary provision might be made for them in the Estimate of the Departmental expenses for 1870–1, which was proposed to be considered to-day by the Commission.

16. Three different modes of comparing the gilt brass kilogram for the Standards Department with the platinum

21st Meetin 19 Nov. 1

standard kilogram of the Conservatoire. First, by weighing the two standards in air and allowing for the difference of air displaced by each; secondly, by weighing them separately in an exhausted receiver so that no correction for the difference of volume was requisite; and, thirdly, by weighing them in a vacuum balance, that is to say, a balance placed in an air-tight case from which the air was as far as possible exhausted, whilst any remaining pressure was accurately measured from time to time by a communication between the inside of the case and a mano-barometric tube and the necessary correction made.

In the second mode of comparison, the air appeared by the mercurial gauge attached to the air pump to be so nearly exhausted that the pressure marked was less than a millemetre; in the third, the mercurial gauge attached to the two air pumps used did not show a less pressure than 10^{mm}, and the lowest pressure during the actual weighings was 19^{mm}.

Upon comparing the results of many weighings by these three processes, it was found that whilst there was a close approximation of the results of the first and third, there was a constant difference between them and the results of the second process; when the weight was placed in an exhausted receiver, the brass kilogram of the greatest volume appearing to be relatively lighter about 8^{mm}.

The vacuum balance used was recently constructed by Deleuil, and is similar to one used for comparing the Prussian kilograms at the Conservatoire in 1860, and then purchased by the Prussian Government. It is described in M. Brix's account (see Appendix to Second Report, p. 26). If such a balance were furnished for the Standards Department, the air might be exhausted with the large air pump now being put into order by Messrs. Troughton and Simms. Deleuil's charge for the balance is 80*l*., and the Commission might determine whether it should be constructed by him or by Oertling. He had communicated with Mr. Oertling, who was ready to undertake the construction of a balance upon a similar principle at the same estimated cost, and this would afford an opportunity of making any alteration or improvement of the mode of construction that might be thought desirable.

Professor Miller was of opinion that the Department should be furnished with such a vacuum balance. An arrangement might be advantageously made for changing the weights without opening the balance case and having to re-exhaust the air. It would be advisable also to adopt Sprengel's apparatus, by which a further exhaustion of air as low as 3^{mm} might be obtained, the additional cost being about 3*l*. He thought that the work should be entrusted to Oertling.

The Chairman and the President of the Royal Society both concurred in this opinion.

17. The Warden then described the apparatus used for determining the co-efficients of expansion of standard measuring bars, which had been applied to the two brass metres destined for the Standards Department.

A steel bar with two pins passing through it perpendicular to its plane, and having pointed ends exactly a metre distant, was placed in a trough, which could be filled with melting ice, the points passing through and below the bottom of the trough. This was placed in a suitable frame, from which it could be easily taken and replaced, and below it was a copper trough, which could be raised or lowered, underneath which was a gas tube with a number of small burners. A metallic bar placed in this copper trough at the temperature of the air could thus have marked upon it, say at 18° C, two small dots, to show the length of a metre at 0° C upon the bar when at 18° C; and by filling the copper trough with melting ice, or with distilled water brought to the boiling point, other dots could be marked to show the length of a meter at 0° C on a bar of the temperature of 0° C, or 100°, or in fact any intermediate temperature, from which the rate of dilatation could be easily and accurately determined.

He had described this apparatus to Mr. James Simms, who was prepared to undertake the construction at a cost of 40*l*., so far as could be estimated.

The Chairman thought that this apparatus was also necessary for the Standards Department, and it was so agreed by the Commission.

18. The next point brought under consideration was that of gilding standard weights.

The Warden said that the two standard kilograms destined for the Standards Department were of brass amalgam gilt, and belonging to a series of many more constructed by Gambey for the Conservatoire above 20 years ago. General Morin and M. Tresca both assured him that none of these gilt standards had been injuriously affected

21ST MEETING, 19 Nov. 1869.

by the air during this period, and that there was no perceptible change in their weight from this cause. He had also consulted M. Brouilhet, of the firm of Christofle and Co., the well-known goldsmiths, who had made many experiments on the thickness of gold requisite for the protection of an oxydisable metal under it. M. Brouilhet had found that 1 gramme of gold upon a surface of a square decimetre was insufficient, 1½ gramme was barely enough, and that 2 grammes were requisite; he considered that electro-gilding was not satisfactory for protecting the surface of standard weights, and that gilding by amalgam should be employed.

The Warden added that the two gilt standard weights which appeared to have gained in weight, attributable to oxydation, were the 10 lb. standard and the Exchequer kilogram, which had both been originally verified by Professor Miller, and were now found to be in excess, one more than 2 grains, the other 0·2 gr. These were electro-gilt by Ladd and Streatfield, and he had been unable to learn the quantity of gold on them. Mr. Oertling informed him that the series of electro-gilt bullion weights, none of which appeared to have been injuriously affected by the air, had considerably more than 2 grammes of gold per square decimetre upon them.

Some experiments had been made at the Conservatoire of platinizing brass weights, but there was a difficulty in getting the two metals to unite. M. Brouilhet had proposed first slightly gilding the brass before platinizing it, and some experiments were to be made of this process.

19. Upon the subject of his visit to France, the Warden said that he had taken the opportunity of visiting the principal Bureau de Vérification des Poids et Mesures at Paris, and one of the other Bureaux, and had inspected all their instruments of verification and the methods of using them, as well as inquired into the mode of performing their duties. He had particularly inquired into their method of verifying balances, and had ascertained that there was no practical difficulty found in carrying out this duty.

20. The Warden thought it incumbent upon him also to report to the Commission that at the Conservatoire Impérial des Arts et Métiers there is a large and interesting collection of objects connected with their duties which is publicly exhibited, one large hall being devoted to weights and measures and instruments relating to them, amongst which are copies of the standards of many foreign countries. But he was sorry to see in the collection no weights and measures of the United Kingdom, except the copies of the imperial yard and pound legalized in 1853, and he thought it would be creditable to this country if this want could be supplied, and a series of our weights and measures added to their collection.

21. The Chairman said that the Warden had communicated with him from time to time on the subject of his going to Paris, and he had considered that it would be highly beneficial for the Standards Department. He was glad to find that such had proved to be the case, and that much advantage had been gained by this personal communication between the heads of the Departments in England and in France. Some of the other points to which the attention of the Commission had been called had also been brought under his notice, and he now begged to propose the following resolution:—

The Standards Commission desire to acknowledge the prompt action and liberal spirit with which the French Government have acceded to the request of Her Majesty's Government, made in pursuance of the recommendation of the Commission, to furnish for the use of the Standards Department accurately verified copies of the primary metric standards at Paris, as well as a complete set of metric standards and apparatus, such as is used in the local Bureaux de Vérification.

They desire at the same time to express their sense of the frank cordiality with which the Warden of the Standards was invited by the Directeur and Sous-Directeur of the Conservatoire Impérial des Arts et Métiers at Paris to co-operate in the verification of the copies of the primary metric standards, and of the advantage to the Standards Department of its chief officer being thus enabled to observe the instruments and mode of verification adopted in France, and to take part in all the operations there conjointly with M. Tresca, the Sous-Directeur.

They recognize also the same liberal spirit which has been manifested by the French Government in taking steps for the meeting at Paris of an International Commission for the construction and verification of metric standards of a primary character to serve as a basis of an international system of weights and measures; and they wish to express their satisfaction at the invitation to foreign Governments to appoint delegates to take part in all the proceedings of this International Standards Commission.

Whilst giving to the Commission an account of his proceedings at the Conservatoire Impérial des Arts et Métiers the Warden of the Standards has called the attention of the Commission to the fact that a large, valuable, and well-arranged collection of standard weights and measures, both of France and other countries, is deposited and publicly exhibited there; and that whilst complete sets of the weights and measures of many foreign countries are shown, there are no specimens of Imperial weights and measures, except the copies of the Imperial standard pound and yard, presented by the Astronomer Royal in 1857.

The Standards Commission are of opinion that an opportunity is now afforded of most fitly acknowledging the liberality of the French Government by the presentation to them from Her Majesty's Government of a complete set of copies of the Imperial standard weights and measures, accurately verified in the Standards Department, for the purpose of being deposited at the Conservatoire Impérial des Arts et Métiers. They beg, therefore, earnestly to recommend this proposition to the favourable consideration of Her Majesty's Government, and that the necessary steps be at once authorized and taken for carrying it into effect.

With this object they request the Warden of the Standards to communicate a copy of this resolution to the Board of Trade, together with a list of the copies of the Imperial standard weights and measures, and an estimate of the expense, which may be submitted to Her Majesty's Treasury.

The following list and estimate was then laid before the Commission for their consideration by the Warden of the Standards:—

ESTIMATE for a SET of COPIES of IMPERIAL STANDARDS for the FRENCH GOVERNMENT, constructed of the same Metal as the Imperial Standard Yard and the more recent Official Standards, viz., Bronze, of Copper 16 parts; Tin 2½ parts; Zinc 1 part. Mr. Baily's Metal.

	£	s.
Mr. Oertling:		
1 set of avroidupois weights, 56 lbs. to ½ dram. - - -	40	0
1 set of Troy weights, 1 lb. to 1 grain	3	0
1 set of decimal bullion weights, 500 oz. to 0·001 oz. - - -	25	0
A 10 lb. weight - - -	3	15
A set of decimal grain weights, 1,000 gr. to 0·01 gr. - - -	1	15
Cubic foot bottle - - -	12	12
	86	2
(A standard weight of 62·321 lbs., the legal weight of a cubic foot of water, can be spared from the Standards Department.)		
De Grave, Short, and Fanner:		
A set of measures of capacity, 1 bushel to ½ gill - - - -	60	0
Troughton and Simms:		
Copy of new commercial standard of length, and measuring apparatus attached - - - -	50	0
George Glover and Co.:		
Copy of 1 cubic foot gas measurer, &c. - - - -	130	0
	326	2
And copies of any further new standards legalized in the United Kingdom viz.: Standard chain of 66 feet - - „ measure of wine bottle, ⅙ gallon - - - Standard measure of ½ wine bottle, $\frac{1}{12}$ gallon - - - &c. &c. - - -	33	18
Total - -	£360	0

The gilding of the weights would cost 32*l.* 5*s.* additional, and copies of the 5-feet and 10-feet gas measuring standards 250*l.* and 350*l.* respectively.

The Commission approved of the above list and estimate of 360*l.*, being of opinion that Baily's metal was a very desirable alloy, little tarnishable by oxydation, and not requiring to be gilded; and that the one cubic foot gas measurer sufficiently represented the gas-measuring standards, which are costly instruments.

They approved also the suggestion of the Warden of the Standards, that in the event of the presentation of these copies of the Imperial Standards being authorized by the Government, he should invite M. Tresca to assist in the operations of verification in the Standards Department.

22. An application from Mr. Skinner, who had given much valuable evidence to the Commission, to reimburse him for his time and expenses in preparing models of weights and measures, collecting information, &c., and enclosing an account amounting to 10*l.* 10*s.*, was submitted to the Commission by the Warden of the Standards who recommended that it should be paid. Payment was accordingly sanctioned.

23. The letter from the Home Secretary, calling for an estimate of the expenses of the Commission for 1870–1, and for a statement of the total expenses of the Commission, the progress made, and the probable termination of their duties, was laid before the Commission.

The following return was agreed to:—

Standards Commission.

	£
Estimate for 1870–71:—	
Incidental expenses, including travelling expenses of the Commission -	100
Estimated total expenditure of the Commission, viz.:—	
From the commencement up to 31st March 1870 - - - - -	250
In 1870–71 - - - - -	100
	£350

This sum does not include any remuneration which may be awarded to the Secretary.

The Commission have issued their First and Second Reports, and they have begun their meetings since the autumnal recess, and have made great progress towards the completion of their—

Third Report, on the abolition of troy weight and substitution of metric or avoirdupois weight;

Fourth Report, on the system of inspection of weights and measures in the United Kingdom;

Fifth Report, on the reverification of the Official Standards of the Board of Trade and on the business of the Standards Department;

having examined 24 witnesses, who have given much useful information on the several points referred to the Commission, in 3,154 answers to questions.

Under the superintendence of the Commission much valuable and scientific apparatus has already been added to the equipment of the Standards Department, and more is being constructed or has been recommended by the Commission to be constructed. The reverification of all the Official Standards and the verification of new standards, especially of those on the metric system, is far advanced.

So far as regards the immediate objects for which the Commission were appointed, it is expected that all these objects will have been accomplished by 30th June 1870, as stated last year. It was also then stated with respect to the termination of the Commission, that the nature of their duties is such that it would probably be found necessary to revive the Commission from time to time, after the more immediate objects had been attained.

It may remain for consideration how far the further labours of the Commission may be requisite for sanctioning and carrying out the objects recommended by them in their several Reports, more especially the preparation of detailed instructions to the local Inspectors of weights and measures, for the better and more uniform execution of their functions.

Considering also that an International Commission for the construction and verification of metric standards, as the basis of an international system of weights and measures, has been proposed by the French Government to meet at Paris, it would appear to be not only desirable but in conformity with the Royal Warrant of appointment of the Standards Commission in this country, that they should be enabled to meet from time to time in order to consider any important question that may arise in connexion with the International Standards Commission at Paris, more especially as relates to any International Standards to be constructed and verified for the United Kingdom.

24. The Warden reported to the Commission that Messrs. Tylor had informed him they have already expended more than the 50*l.* granted on account of their new gallon measure, in consequence of the additions which were not at first contemplated, and asking for an additional sum of 50*l.* for proceeding with it. They had made a displacing cylinder, which, when adjusted, would deliver exactly 70,000 grains into the lower vessel; and they stated that their instrument was also exactly adapted to determine the specific gravity of different metals by a quicker process than had been hitherto used.

The Chairman was disinclined to authorize any further expenditure on account of this experimental gallon measure, and the Commission requested the Warden to inform Messr. Tylor accordingly to complete and deliver this measure as soon as possible, and send a final account of the cost.

25. The subject of the actual expenditure on account of new standards and apparatus for the Standards Department in 1869–70, of the sum recommended by the Commission, and granted by Parliament, was then considered, as well as the estimated departmental expenses for 1870–1, now required to be laid before the Treasury.

The Warden submitted the following statements:—

Estimate and Parliamentary Grant, 1869–70.

	£	s.	£
Ordinary contingent expenses of the Standards Department, including weekly wages of additional mechanic temporarily employed, and repairs, adjustments, &c. of standards and apparatus - - - - - -			250
Extraordinary expenses of new standards and apparatus, recommended by the Commission, viz.:—			
From Messrs. Tylor—			
Set of metric standards - -	*50*	*0*	
Still and apparatus - -	*96*	*5*	
For new *gallon* measure (on account - - - -	*50*	0	
Messrs. Troughton & Simms—			
New commercial standard of length and attached apparatus	100	0	
Reconstruction of Mr. Sheepshanks' apparatus - -	70	0	
Stereometer - - -	15	0	
Total of which estimates given - -	381	5	
New standards recommended by the Commission not less than -	318	15	
Total			700

A detailed statement was exhibited showing payments already made and expenditure incurred, estimated to be payable in 1869–70, to the total amount of 950*l.*

Estimate, 1870-1.

	£	£
Ordinary contingent expenses, including pay of mechanical assistant (total in 1869–70, 130*l.*), and additional charwoman, now required for increased number of offices, 30*l.* - -		160
Repairs and adjustments of standards and apparatus, and sundry new small apparatus -		140
		£300
Extraordinary expenses of new standards and apparatus, recommended by the Standards Commission, viz.:—		
Mr. Oertling—		
New vacuum balance - - -	80	
New balance for kilograms - -	30	
Set of new official metric weights of distinctive pattern for local standards and commercial weights -	60	
		170
Messrs. Troughton & Simms—		
Improved cathetometer for vertical measuring - - -	50	
Apparatus for determing co-efficients of expansion of standard bars -	40	
Do. for measuring solid bodies -	*120*	
Experimental cube, cylinder, &c. -	*25*	
4 cylindrical kilograms, accurately measured - - - -	10	
		245
Total for which approximate estimates made -		415

21ST MEETING,
19 Nov. 1869.

	£
Brought forward - - -	415
Other new standards and apparatus for which no approximate estimate can be made, viz. :— Air thermometer, new metric standards of capacity of distinctive character, new imperial standards of capacity, standard chain, cubic foot apparatus, photometer, experimental meter, gold coin standard weights, &c., say - - -	285
Total -	£700

This estimate of the Departmental expenses for 1870–1, was approved by the Commission and recommended for adoption, the Chairman stating that at the present time when the subject of Standard weights and measures had attracted so much attention, both here and abroad, the Department ought to be supplied with all the instruments of precision of the highest scientific accuracy, that might be requisite for the most efficient discharge of their duties.

26. The Warden said that with the view of carrying out the recommendation of the Commission for constructing mural or public standards, he had been in consultation with Mr. James Simms as to proceeding with them. He proposed to place mural standards of imperial measures of length, similar to those outside the gate of the Royal Observatory, Greenwich, on the outside wall of the Standards Department, together with similar mural standards of metric measures of length. Drawings of these mural standards had been prepared by Mr. J. Simms, and were now before the Commission.

With respect to public standards of the chain and other measures of length, Mr. Mellor had previously informed him of the mode in which a public standard surveyor's chain of 66 feet, with other measures of 10, 50, and 60 feet, had been laid down under his directions at Manchester, along a covered way in front of the Town Hall. The lengths were defined upon gun-metal blocks let into the pavement and level with it, being fixed by Portland cement. Each block is a cube of three inches, formed of four rectangular pieces 1½ square in horizontal section and three inches high, soldered together. Thus, one soldered line placed in the direction of the length, shows where the measure is to be taken, and the intersection of the cross line defines the length, and these must continue unaltered in spite of wear so long as any portion of the gun-metal block remains. He considered that this plan might be adopted, the blocks being let into a dwarf stone wall, about 15 inches high.

But on visiting with Mr. J. Simms the space of ground on the south side of the Victoria Tower, which had been recommended as a fit place by the Commission at their sixth meeting, he was informed by the policeman on duty at the entrance, that the ground was private, and he had orders from the Great Chamberlain's department that no one should be admitted.

The Chairman said that a communication should be at once made to the Great Chamberlain upon the subject, as the place selected appeared to be a very convenient one for the purpose. A length of 100 feet should be laid down.

27. The correspondence relating to Post Office weights, contained in Paper III.–VI. was then brought under consideration.

Professor Miller objected most strongly against the introduction of a Post Office weight of ⅓ oz. for foreign letters, when so excellent an opportunity offered itself for introducing the metric 10 gramme weight, as an international weight, and the Commission concurred with him. The question was left for future consideration when the Post Office authorities should have further considered it and stated their views.

28. With respect to a distinctive form of metric weights, upon which an early decision of the Commission would be requisite, the Chairman said a proposition had been submitted to him by the Warden, after consultation with Mr. Short, of the firm of De Grave & Co., who constructed the Post Office weights. The question applied more immediately to brass weights, as it was obvious that the regulated form of French iron metric weights, being hexagonal, was at once easily distinguishable from the existing forms of iron imperial weights.

The proposal was that the regulated form of French brass cylindrical weights with a knob should be adopted. He thought it would be better that these weights should also have a rounded groove turned at half the height of the cylinder, which would not add to their expense and would render them at once distinguishable as metric weights.

21ST
MEETING,
19 Nov. 1869.

Specimen flat brass weights of 10 grammes and 20 grammes, with the edges rounded, had been prepared by Messrs. De Grave and were now before the Commission. He considered that these would be useful, but that the denomination should be marked upon both the flat sides. It would be requisite on a future occasion to determine the scale of weights to be made of this flat shape and their exact dimensions.

In the meantime the Chairman recommended that the Commission should express their general approval of brass metric weights of these two forms, which might be adopted as Post Office weights.

The Commission concurred in this recommendation.

29. It was agreed that the next meeting should be on Friday, December 3, at 11 a.m.

The Commission adjourned at 3.45 p.m.

G. B. AIRY,
Chairman.

22ND
MEETING,
3 Dec. 1869.

TWENTY-SECOND MEETING.—FRIDAY, 3rd DECEMBER 1869, at 11 a.m.

PRESENT :

The Astronomer Royal (Chairman).
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The minutes of the 21st meeting, which had been printed and distributed, were confirmed.

2. As to the question of the abolition of troy weight :—

Two letters from Mr. Willoughby, silversmith, of Windsor, stating the custom of the retail trade in buying and selling gold and silver wares, which had also been printed and distributed, were laid before the meeting.

The Chairman read a letter addressed by the Secretary to Messrs. Sloane and Carter, silversmiths, &c., 89, Spencer Street, Birmingham, requesting information for the use of the Commission, and their reply, to the effect that the abolition of troy weight was not, in their opinion, desirable. They thought it would be more satisfactory that Mr. Carter, junior, should attend the Commission to answer any questions upon this subject.

Mr. H. Carter, jun., who was in attendance, was then examined.

3. The question of an air thermometer, its mode of construction, and use in the Department, more particularly for ascertaining the temperature of the air in comparisons with the gas-measuring standards, was then considered.

The Chairman read a letter from Mr. Balfour Stewart, stating that the Kew Committee had resolved that the construction of a standard air thermometer necessarily involved a number of preliminary experiments, the extent of which it was impossible to foresee. The cost would probably not exceed 250*l*. The Committee were prevented, by pressure of other business, from undertaking these experiments till after a period of six months.

He was of opinion that as the construction of an air thermometer for the Standards Department by the Kew Committee appeared to be a matter of much uncertainty, and involved considerable expense for preliminary experiments, it must be, for the present, abandoned. An air thermometer was not required for daily use, but for ascertaining the relative expansion of the air and of mercury.

Professor Miller could not conceive that anything more was required for the Department than an instrument to give the exact temperature of air at about 50°, as well as at 0° and 100° C.; and to ascertain from the air thermometer, by the use of a proper formula, that the mercurial thermometers were reading correctly. The air thermometer would not be used for actual observations of the temperature, but for checking the mercurial thermometers. He thought the estimate given by the Kew Committee was rather for experiments which would have to be made, and that an air thermometer sufficiently correct, as designed and used by M. Regnault could be obtained from Paris for about 20*l*. The air thermometer was more reliable than a mercurial thermometer for showing the temperature and thermometric expansion of air.

The President of the Royal Society said it was certainly desirable that one of these instruments, resting as they did on M. Regnault's authority, should now be obtained from Paris for the Standards Department. Mr. B. Stewart had himself made several experiments on the construction and action of an air thermometer, and the results differed to

22ND MEETING, 3 Dec. 1869.

some extent from those of M. Regnault. He, therefore, considered that many further experiments would be required before any satisfactory determination could be arrived at, and these must entail considerable expense.

Professor Miller thought that the discordance might probably be owing to the kind of glass of which Mr. Stewart's instruments were made. Regnault had found contradictory results from using thermometers made of different kinds of glass. He would ascertain the best mode of obtaining from Paris one of Regnault's instruments.

The Warden of the Standards was requested to communicate to the Kew Committee that the Commission abandoned for the present the proposed construction of an air thermometer by them; and the Commission authorized him to take the necessary steps, as soon as he heard further on the subject from Professor Miller, for obtaining from Paris an air thermometer as recently designed and used by M. Regnault.

4. A drawing by Messrs. Troughton and Simms of the mural standards of length fixed outside the gate of the Greenwich Observatory, under the Astronomer Royal's directions, was examined by the Commission, who concurred with the Warden that it would be desirable to have similar standards of Imperial and Metric measures of length fixed on the outside of the Standards Office. It was left to the Warden to give the necessary directions.

5. The Warden said that since the last meeting, he had spoken to Mr. Fincham, the Clerk of the Works of the Houses of Parliament, on the subject of laying down public standards of the surveyors' chain, &c. in the vacant space on the south side of the Victoria Tower. Mr. Fincham recommended that an application should be made to the First Commissioner of Works, rather than to the Lord Great Chamberlain.

The Chairman and other members remained of opinion that this would be a very suitable place for the purpose, and considered that the standards should be placed near the wall, so as to be shaded from the sun.

They subsequently went to inspect the ground in question, and were joined by Mr. Fincham, who said that a difficulty might arise in obtaining permission for laying down the standards on this spot, and in admitting the public, who were not now allowed to enter. He suggested that the difficulty might be obviated if the space on the north side of the enclosure in New Palace Yard were chosen.

The Commission next inspected this spot, where the standard could be laid down on flag stones placed level with the grass, and just inside the curb stone.

It was left to the further consideration of the Chairman whether this place should be chosen, in accordance with Mr. Fincham's suggestion.

6. The Warden exhibited a set of glass weights made by Dowling, referred to at the last meeting, together with a wooden gill measure, turned out of solid wood, and bearing the inspector's stamp, which had shrunk so much that its capacity did not now exceed half a gill; and an iron 1 lb. weight, recently readjusted and stamped by an inspector in a county adjoining the metropolis, who was a policeman, the pound being 1½ drams overweight.

7. He also exhibited some Post Office metric weights from Germany, left, at Professor Miller's suggestion, by Mr. Griffin, a philosophical instrument maker. They were of brass, and cubes with the edges rounded off, having the denomination marked on each of the sides.

Professor Miller suggested for consideration whether the new metric weights of brass should be made merely of a cylindrical form with a deep and rounded groove or belt at one third the height of the cylinder from the top, and without a knob: the edges of the cylinder to be also well rounded.

8. The Warden said he had to report to the Commission the reverification of several of the official standards, the details of which would be laid before them in a printed form.

The standard weight of 62·321 lbs. or of the cubic foot of water, which had been shown, on reverification, to be much too heavy, had been readjusted by Mr. Oertling; its legal standard weight in grains was 436,247 grs., and it had now been determined to weigh 436248·20858 grs., being 1·20858 grs. in excess.

Professor Miller's 10 lb. weight of gilt gun metal, being the weight of water in a gallon, had been readjusted by Mr. Oertling, who had also readjusted the new 10 lb. weight of Baily's metal, recently constructed by him, and which on its first comparison had been found rather more than 1 grain in excess. Some further comparisons had been made of Kater's 10 lb. weight, which proved to be unaltered since its reverification in 1827. The actual weight of these standards has been found to be as follows :—

22ND MEETING, 3 Dec. 1869.

Grains.
Kater's 10 lb. weight (K) = 70000·24972
Miller's „ (M) = 70000·22333
New official „ (O) = 70000·54593

These results were accepted by the Commission.

9. All the official standard measures of capacity had also been reverified by weighing their contents of freshly distilled water, and correcting the weighings by Professor Miller's new tables of corrections for temperature and barometric pressure. The larger measures were tested by the bullion standards, those of intermediate size, including the gallon, with the 10 lb. standards, the smaller measures with the gilt gun-metal pounds and decimal grain weights. The results are as follows :—

Denomination of Measure of Capacity.	Actual Weight of Contents of Distilled Water.	Error	
	In Grains.	In Grains.	In Parts of a Cubic Inch.
Official Standard Bushel -	555916·65643	−83·34357	−0·33013
„ Half Bushel	279952·61481	−47·38519	−0·18769
„ Peck -	139974·50787	−25·49213	−0·10097
„ Gallon -	70000·20530	+ 0·20530	+0·00081
„ Half Gallon	34994·48812	− 5·51188	−0·02183
„ Quart -	17498·19736	− 1·80264	−0·00713
„ Pint -	8749·53694	− 0·46306	−0·00182
„ Half Pint -	4374·99871	− 0·00129	−0·00000
„ Gill -	2187·27879	− 0·22121	−0·00087
„ Half Gill -	1093·30741	− 0·44259	−0·00175

The Warden suggested that the bushel, half bushel, and peck standard measures be sent to Messrs. De Grave for readjustment; that the reverification of the remaining measures of capacity be accepted, and that they be considered as practically correct for official comparisons. The ascertained errors of all these official standards of capacity, including the bushel, is considerably within the limits of tolerance provisionally sanctioned by the Commission, as shown in Paper IV.—1. This was agreed to by the Commission.

The Chairman remarked that some difficulty might occur in the comparison of measures of capacity, when filled with water, from the flexure of the middle of the glass disc placed upon them. It was explained that such had been found to be the case in comparing the official standard bushel, the flexure of which displaced water of the weight of more than 20 grains, and a glass disc, 1 inch, was now being specially constructed to avoid that difficulty. The flexure of the glass on the smaller measures of capacity was not appreciable.

Professor Miller thought it desirable to place a sensitive spirit level upon the glass when it was on the measure, in order to ascertain the amount of flexure.

10. The Warden referred to the preliminary comparison of the official standard yard, reported to the Commission at the 6th meeting, on 10th July 1868, to have been found about 0·0015 in. less than the imperial standard, the provisional allowance for error for the local standard yard being 0·005 in. The actual deficiency of the official standard of 1824 was now determined to be 0·001374 in., its standard length being 35·998626 in.

A comparison had also been made of the four standard yards with gold points, constructed by Kater in 1824, as standards of reference, and which had been transferred from the Treasury to the Exchequer in 1865. These four standard bars had been repeatedly compared by Kater with the Shuckburgh scale, and no perceptible error could be detected in any one of them. The results of the present comparisons were as follows :—

		Inches.
Kater's standard yard with gold points - - -	No. 1	35·998278
	No. 2	35·998386
	No. 3	35·998663
	No. 4	35·997943
Mean -		35·998318

The length of the official standard yard of 1824, which had also been verified by Kater, is thus found now to approximate very closely to No. 3.

These four yards were compared with the bronze line standard yard, No. 6, which had been found, in 1855, to be so nearly identical with the imperial standard as to have the same standard temperature assigned to it, the difference being less than 0·01° Fahr. Bronze No. 6 (or 28 by the old numbering) had then been found in excess of the standard 0·03° of the micrometer, or +0·000001074 in. By a comparison now made of No. 6 with the imperial standard, No. 6 was found in excess 0·02° div. of the micrometer used or +0·00000076 in. The difference is within the errors of observation, and it may be considered that the new standards are still identical in length, and that no appreciable difference has occurred in either standard measure in the 14 years which have elapsed since their original comparison.

The verification has also been completed of the length of the yard marked upon the new subdivided standard measure of length (SS), intended as the scientific standard. It has been compared with No. 6, and found at 62° Fahr. to be deficient 0·0000905 in., or =0·9999195 yard, and thus to be exactly equal to the standard when at the temperature of 62·26° Fahr.

The verification of the subdivisions of the yard, as well as of the metre marked upon this bar, is delayed until the new sliding measure is constructed by Messrs. Troughton and Simms, and until the repairs of the Tower, which interfere with the comparing operations, are completed.

11. A preliminary comparison has been made, so far as regards the length of the yard marked upon it, of the new commercial standard measure of length, distinguished as CS, and having a comparing apparatus attached. This instrument was delivered by Messrs. Troughton & Simms, on 10th November, and has been temporarily placed in the weighing room. By means of the vernier, which indicates a difference of 0·001 in., the yard was found not to differ sensibly from the bronze end standard yard, No. 69 (determined, in 1855, to be equal to the standard when at the temperature of 61·67°), whilst it exceeded the length of the official yard of 1824 by rather more than 0·001 in. This preliminary comparison must therefore be deemed satisfactory.

The Warden read a Departmental Minute, dated 3rd December 1869, stating these particulars, and directing that in future all comparisons of copies of the imperial standard yard be made with the new official standard of length, CS, and that the official standard yard of 1824 be used only for checking the comparisons made with the new standard. The use of the rod with handles to be discontinued.

The Commission approved of this Minute, and of the results of the official comparisons of the standard measures of length.

12. The new commercial standard of length and its attached apparatus was then inspected by the Commission, to whom the mode of using it was exhibited. The Warden showed that an eye-piece was wanted for reading the vernier, and some contrivance was required for regulating the pressure of the screw which determined the contact between the rectangular jaws of the comparing apparatus and the ends of the measure under comparison, and also determined the amount of difference between the measures. He had drawn the attention of Mr. James Simms to these points.

Professor Miller thought that some method of regulating the pressure might be adopted like that of the German fühl-hebel, or fühl-niveau.

The Astronomer Royal said that the arrangement would require some consideration how it could best be done, and he would think over the matter.

13. The progress of verification of the official metric weights was then stated to the Commission.

The Warden said that he had forwarded yesterday to M. Tresca a draft official statement of the operations at Paris for verifying the metric standards, as previously arranged, the results of these operations having been agreed to by M. Tresca and himself, before he left Paris. The draft would be revised by M. Tresca, and an account of any further operations added. It is purposed hereafter to lay this statement in a printed form before the Commission.

Since his return, the gilt brass kilogram, 𝔎𝔅, which he had brought from Paris, and which had been determined to be 4·16 mgr. in excess of the primary standard, had been compared with the gilt gun-metal kilogram 𝔎, originally verified by Professor Miller, and recently found on verification to be 10·34 mgr. too heavy. The result of this comparison was that after allowing for the difference of air displaced 𝔎𝔅 was found 4·41 mgr. in excess. This close approximation of the two comparisons was most satisfactory, as it also confirmed the accuracy of the reverification of the weight of 𝔎.

The metric weights purchased from Messrs. Tylor (distinguished as series 𝔗) have been verified from 1 kilogram to 1 gram, by comparison with it, and with each other; a similar verification having been at the same time made of the series of standard metric weights received from the Mint (distinguished as 𝔐), and which had lain at the Mint from 1818 to 1868. These weights are now in good condition, though somewhat discoloured by oxidation.

The following are the results, showing the actual weight of each standard, in terms of the Kilogramme des Archives:—

Series of official Metric Weights, 1 kilogram to 1 gramme.

𝔐 Grms.	𝔐 Grms.	𝔗 Grms.	𝔗 Grms.
1 kilogram, or =	1000·001868	1,000 =	1000·000108
500 =	499·996599	500 =	499·999107
200 =	200·000852	200 =	200·006735
100^1 =	99·999420	100 =	100·001774
100^2 =	99·999574		
50 =	49·997085	50 =	50·002242
20 =	20·000046	20 =	20·001030
10^1 =	10·000696	10 =	10·000252
10^2 =	10·000408		
5 =	4·999543	5 =	5·000370
2 =	2·000009	2 =	2·000200
1^1 =	1·000156	1 =	0·999962
1^2 =	1·000216		

The larger metric weights of 2, 5, 10, and 20 kilograms, will be verified as soon as the verification of the 10 new kilograms shall have been completed. These new kilograms are now being weighed in water, according to the method adopted by Professor Miller, for determining their densities, and they will also be weighed in air for the purpose of determining their standard weight. Three sets of the smaller metric weights, from 1 gramme to a milligram, have been procured from Messrs. Deleuil, at Paris, and will be verified as soon as may be.

14. With reference to increased office accommodation, recommended by the Commission at the 19th meeting, on 28th July (s. 11), the Warden reported that his application has been acceded to by the Board of Works, and the new arrangements are now far advanced. The larger room in the basement of the Tower is being fitted up, to be used as a weighing room, and already presents a beautiful appearance, with its arched and groined ceiling, now being restored as originally constructed under Abbot Liddington, in the 14th century. He proposed at once to move the messengers' room, the room inside the gas-measuring room, so that the comparing operations there should not be disturbed, and to transfer them to the clerks' room nearer the entrance, which would afford better security to the many valuable instruments deposited in the office. This was the more requisite as many robberies had lately been effected in the neighbourhood, and the Commissioners of Police had given warning that extra precautions ought to be taken. The clerks would be moved to the rooms on the second floor. These proposed arrangements were approved by the Commission.

15. The mode of construction of the remaining new standards of length and capacity, recommended by the Commission in the First Report, was then brought under consideration.

The Warden exhibited specimens of a surveyor's chain of 66 feet, and of the chain of 100 feet, used for measuring land for building purposes, which he had procured from Messrs. Troughton & Simms. These were of ordinary construction, and he had directed specimens of the best construction to be furnished, which would be deposited in the Standards Department. It would be necessary that proper standards of these measures should be procured for official use, copies of which might be verified for the local inspectors, and a standard measure of 10 feet was required.

The Chairman said that the public standards of a chain would be found practically to be very serviceable for correctly ascertaining the proper length of the chains used by surveyors. He considered that for the official 10 foot standard, an iron bed divided into feet and inches would be preferable. Comparisons and verifications of the standard length of the chain of 66 feet or 100 feet would best be made by means of two 10 feet standard bars moved along in the ordinary way, and by using also a 6 foot standard bar. The bars should be of iron, probably square in section, with the ends bevilled from the opposite surfaces so as to form a somewhat thick edge, and so that when placed on the ground the edge at one end should be vertical, and at the other end horizontal. When used for comparisons, they might thus be placed in a straight line with a vertical line in contact with a horizontal line. The bars should be kept down in their place by weights placed upon them. Mr. James Simms would know how such standard measures could be practically constructed.

22ND MEETING, 3 Dec. 1869.

Professor Miller concurred in this opinion. The measuring bars used by Gauss and Bessel were square in section, with the ends very much like the knife edges of a balance, but made tolerably obtuse, and the edge at one end was made perpendicular to that at the other end.

It was left to the Warden to arrange with Mr. James Simms for the construction of these standards of length.

16. With reference to the construction of a standard wine bottle, and half bottle, of $\frac{1}{6}$ and $\frac{1}{12}$ gallon, the Warden said he had been in communication with Messrs. De Grave & Co. upon the subject. Mr. Short informed him that he believed they had in their possession specimens of the old wine quart and wine pint, deduced from Queen Anne's wine gallon of 1707, and they would endeavour to find them and send them to this Office.

The original standard gallons of Henry VII., Queen Elizabeth, and the imperial gallon, as well as Queen Anne's wine gallon, were exhibited to the Commission. It was shown that this wine gallon was equal to 0·83 imperial gallon, and thus the wine quart, which was one-fourth of it, a little exceeded $\frac{1}{5}$ gallon.

The Warden said it was necessary now to determine the form of the new standard measures of capacity. The official standards now used were cylindrical, but there were some other standards of capacity, a gallon, quart, and pint, which had been constructed by Captain Kater, as standards of reference, and were of a conical shape, but without the apex of the cone; that is to say, they rested on a broad base, and had a narrow and short cylindrical neck. The capacity was taken to the upper surface of the measure, a glass disc being used in the ordinary way.

Professor Miller thought a truncated cone was a good shape for liquid measures. Very convenient standard measures of wine bottles might be made of glass of the ordinary bottle shape with a neck, and the measure defined by a cut line. Such glass measures were common in Germany, and were much used here at the present time for chemical purposes.

The Warden replied that the cylindrical form was found to be by far the best for official standards, as their capacity could be more conveniently and accurately determined by weighing their contents of water. It was necessary to ascertain not only that the measure was exactly filled with water, for which purpose a glass disc was used, but also that there were no bubbles of air in the water, when the measure was first filled; and more particularly that no undue quantity of water was left in it, when the water was transferred to another measure. The existing official standards of capacity were made of gun metal. The larger measures, intended as dry measures, had the internal diameter nearly double the height, whilst the smaller measures intended for liquids, consisting of the gallon and under, had the diameter about equal to the height. He would propose that the new standard measures, which were all meant to be liquid measures, should be cylindrical, with the internal height half as much again as the diameter. They would thus be readily distinguishable from those existing standard measures from which they will not much differ in capacity. All these cylindrical measures should be slightly rounded inside where the sides meet the bottom, to prevent the water lodging there in a ring. Professor Miller's suggestion that the new liquid measures should be made in the form of glass bottles with necks bearing a defining line appeared worthy of consideration, and might perhaps be well carried out for the ordinary measures to be used by the public, and even for the local standards. In that case, secondary standards might be constructed for the use of the Department, being easily verified with sufficient accuracy in the ordinary way by measuring their contents of of water with those of the cylindrical standards. He could communicate upon this point with Mr. Griffin, who, as he understood, had much experience with glass liquid measures for chemical purposes.

The Chairman thought there was much force in these remarks, and it was left to the Warden to take the necessary steps for carrying them into effect.

17. Tuesday fortnight, 21st December, at 11 a.m. was fixed for the next meeting, when it was hoped that a definite conclusion might be arrived at upon the whole question of the abolition of troy weight, to form the subject of the Third Report of the Commission.

The meeting adjourned at 3 p.m.

G. B. AIRY,
Chairman.

TWENTY-THIRD MEETING.—TUESDAY, 21st DECEMBER 1869, at 11 a.m.

23RD MEETING, 21 Dec. 1869.

PRESENT:

The Astronomer Royal (Chairman).
The President of the Royal Society,
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The Minutes of Proceedings at the 22nd meeting were confirmed.

2. The Warden of the Standards laid before the Commission copies of the following printed papers, which had been circulated:—

Minutes of evidence on 3rd December;

And consequent circular to standard weight and measure makers.

Two letters from Messrs. Sloane and Carter, on the question of abolition of Troy weight.

Paper XVII.-III., with summary of information on the question of abolition of Troy weight, &c., with proposed resolutions.

Letter from the French Ambassador at London to the Earl of Clarendon, inviting representatives from this country to the International Standards Commission at Paris.

3. After reading to the Commission the last-named paper, the Astronomer Royal said that he felt it to be his duty, as Chairman, to call their special attention to the words at the conclusion of the fourth paragraph of the letter of the French Ambassador, referring to the general adoption of the Metric system. It was so far satisfactory to him to observe the omission in this letter of the additional words the "propagation and even the" adoption of the Metric system, which were to be found in the original letter from the Minister of Agriculture and Commerce to the Minister of Foreign Affairs at Paris, and to which he had before stated his objections. He had on former occasions strongly expressed his conviction that the Metric system would not be generally accepted in this country for the purposes of internal trade; and whilst recommending the legal introduction of the Metric system in transactions of an international character, the Commission have specially expressed their opinion that its general introduction here should be permissive only. He thought that not only on their own behalf, but on that of the British public, and more especially the working classes, whose interests they were bound to protect against any doctrinaire innovations, they should be carefully on their guard against any admission inconsistent with their opinion thus stated.

He proposed, therefore, that the Commission should pass the following resolution:—

In receiving amongst their papers the letter from the French Ambassador to the Earl of Clarendon, inviting representatives from this country to the International Standards Commission at Paris, which has been laid before them by the Warden of the Standards, the Standards Commission, whilst cordially approving of the establishment of uniform international standards of the Metric system, as proposed by the French Government, desire at the same time to guard themselves against any extended inference that might be drawn from the use of the words "the general adoption of the Metric system" at the end of the fourth paragraph.

The Commission have already recommended that the Metric system should be adopted as a uniform international system of weights and measures, and that, within the British Isles, its use by those who desire it should be sanctioned by authority. But as regards all internal transactions, the Commission have most carefully expressed their opinion that its general introduction should be permissive only, and that its exclusive use should not be made compulsory by law.

The Standards Commission can therefore recognize the duties of the proposed International Commission as applying only to international objects, and as in no way having cognizance, even by inference, of the system of weights and measures to be adopted within each State.

The President of the Royal Society concurred with the Chairmain in the views he had stated and in the proposed resolution. He thought that the distinction between the two points should be clearly borne in mind,—first, that the Commission should express their entire satisfaction at the proposition of the French Government for the construction of international Metric standards; and, secondly, that they should be careful not to sanction any interference with our system of weights and measures in home transactions.

Professor Miller also expressed his approval of the resolution.

23RD MEETING, 21 Dec. 1869.

23RD MEETING, 21 Dec. 1869.

The Warden said he quite agreed in the propriety of passing the resolution, but he could not imagine that any ulterior purpose was contemplated in the use of the words objected to. They were really the words of General Morin, who, upon receiving a copy of the Second Report of the Commission, had written to him in the following terms:—
" J'ai vu avec plaisir que la question de l'adoption du
" système métrique dans votre pays gagnait du terrain,
" et je pense avec vous que le temps n'est pas venu de
" rien prescire par la loi. Il a fallu plus de quarante ans
" pour qu'en France il fut possible d'en rendre l'usage
" obligatoire."

The resolution was then agreed to by the members present, and the Warden was requested to submit it to the other members of the Commission, for their consideration and approval.

4. The Warden said that he proposed, in his remarks to the Board of Trade upon the letter from the French Ambassador, to call attention to the exact nature of the duties to be performed by the members of the International Commission who might be nominated by the British Government. These duties were precisely similar to those which had been executed by the Commission of 1841 for the restoration of the lost Imperial Standards. It was obvious that there were no men of science in this country so well qualified from their special acquirements and experience, as well as their high reputation at home and abroad, to represent the United Kingdom in the International Commission at Paris, as were to be found in the surviving members of the Standards Commission of 1841, especially the Astronomer Royal, the Chairman of this Commission, who had taken part in and written the account of the construction of the new Imperial standard yard, and Professor Miller, who had exclusively undertaken all the operations connected with the verification of the new Imperial pound, and had written the account of its construction. The Warden added that he should probably be consulted by the Board of Trade as to the men of science to be nominated, and now that the time appeared to be approaching for their nomination he hoped that he might be empowered to state that the Astronomer Royal and Professor Miller would consent to serve upon the Commission, if requested by the Government. He would ask also the President of the Royal Society, not only as a member of this Commission, but as presiding over the highest scientific Society in the kingdom, if he would give his services in the event of his being requested.

The President of the Royal Society said that he had so many engagements that he should be obliged to decline serving upon the Commission at Paris. He considered that it would be of the highest advantage that the Astronomer Royal should be a member of the Commission, and that it would be very desirable that Professor Miller and the Warden of the Standards, from their thoroughly practical knowledge of the subject, should also represent this country. He asked the Warden when it was probable that the Commission would meet, and how long they would be engaged in their labours.

The Warden replied that it would probably be not less than three months before all the preliminary arrangements could be completed for the first meeting of the Commission. He was of opinion that all the detailed work of the Commission could not be completed in less than two years. But the attendance of the representatives of each country would be required for a comparatively small part of this time, as probably after the general course of action had been agreed upon, they would be content with superintending the verification of their own standards.

The Astronomer Royal said that the pressure and variety of matters to which he was now obliged to give his attention were so great that he really feared that he could not give up time to the International Commission at Paris; but after the strong expression of opinion that he should consent to act, he could no longer refuse to be nominated and to attend at Paris during the more important deliberations of the Commission, in order to express his views upon the several subjects on behalf of this country, although it would be impossible for him to assist in any of the detailed operations. He considered that these might be well left to Professor Miller, if he could find time to give his services, and to the Warden of the Standards.

Professor Miller said that his own duties occupied much of his attention and time, especially at particular periods of the year. During the months of February and March he must be constantly at Cambridge to deliver his lectures, and once a month his services were required at the Royal Society. He would, however, be willing to serve upon the Commission at Paris when these other duties did not intervene. If any other member were required, he would suggest Mr. De la Rue, as a thoroughly well informed man of science, and experienced in all matters relating to weighing and measuring.

The Astronomer Royal explained that M. De la Rue, as a friend of Mr. Sheepshanks, had been often consulted, and gave his assistance during the earliest labours of the Commission for reconstructing the Imperial Standard. But, probably, it would be sufficient that three members should be nominated from this country. The Warden was now well acquainted with the views of the Commission upon the subject, and it might be left to him to make his report to the Board of Trade.

5. The Commission proceeded to the consideration of the question of the abolition of Troy weight, and the Chairman read the Warden's final paper, XVII.-III., upon the subject.

Some discussion took place as to the propriety of retaining the paragraphs referring to the Chancellor of the Exchequer's suggestions with regard to a change in the weight and fineness of the gold coinage, and the Chairman expressed his disinclination that any matters should be brought under the notice of the Commission, except they had a direct bearing upon standard weights and measures. It was consequently agreed that some passages should be struck out.

With reference to the most eligible scale for the decimal grain weights, the Warden said that the scale which has been adopted by Lord Monteagle for the decimal grain weights, constructed under his directions by Mr. Oertling, was that of 1, 2, 3, 6, 10, the scale of the decimal bullion weights being 1, 2, 3, 4, 5, 10; whilst the Belgian decimal scale was 1, 1, 2, 5, 10, and the French decimal scale was only 1, 2, 5, 10. He would be glad to have the opinion and the directions of the Commission upon this point.

Professor Miller said that Oertling's scale was found very convenient in practice.

The Chairman considered that upon the whole the scale of 1, 2, 3, 5, 10, was the most desirable, and the Commission agreed that this should be adopted for the decimal grain weights.

The following resolutions were then read seriatim by the Chairman, and after due consideration were unanimously agreed to, when the Chairman attached his signature to them:—

1. Considering,

That in the Reports of the Standards Commission of 1841 and 1854, opinions have been expressed in favour of the simplification of the Imperial system of weights by the abolition of Troy weight;

That Troy weight has since been legally discontinued for pharmaceutical purposes, and Avoirdupois weight substituted under the provisions of the Medical Act, 1864;

That Troy weights are now used only for the precious metals, and for trade purposes by manufacturers and dealers in gold and silver wares;

That the Troy weights so used for trade purposes appear to be the old nest set of ounce weights, increasing in a binary series up to 256 oz., according to the old Standards established by Queen Elizabeth in 1588, which ceased to be the legal Standards in 1824; and that the existing legal denominations of Troy weights, as represented by the official Standards, are not generally used;

That the decimal series of Troy ounces for bullion, legalized in 1853, has never been adopted by the general public;

That it has been shown to us that throughout the United Kingdom only eight counties and thirteen cities and towns are furnished with legal copies of the official Troy Standards, and two counties and five cities and towns with legal copies of the official decimal bullion Standards;

That the legal provisions for stamping and inspecting Troy weights throughout the country have been practically inoperative;

That the legalization of the use of Metric weights has been recommended by us in our Second Report, and the concurrent use of three distinct systems of weights will be inexpedient and tend to produce confusion and complication, more especially as regards the local inspection of weights and measures, as, in the event of the continuance of the Troy system, it would be requisite to provide for an equally vigilant inspection of Troy weights as of other weights;

23RD MEETING, 21 Dec. 1869.

That we have satisfied ourselves, from the evidence of various classes of persons now using Troy weights in business transactions, that there are no sufficiently valid reasons for the continuance of Troy weight which can be placed against the great advantage to the public of simplifying our system of weights by its abolition;

We are of opinion that it is expedient that the use of Troy weights be abolished by law.

2. We therefore recommend that legislative provision be made, that from and after twelve months from the passing of an Act for that purpose—

The provisions of the Act 5 Geo. 4. c. 74., for ascertaining and establishing uniformity of weights and measures, and of 16 Vict. c. 29., for regulating the weights used in sales of bullion, and of any other Act or Acts legalizing or requiring the use of Troy weights, and so far as they relate to the same, be repealed;

All secondary Standards of Troy weight now deposited in the Standards Department of the Board of Trade shall cease to be legal secondary Standards;

All copies of such secondary Standards of Troy weight, verified for the use of local Inspectors of weights and measures, shall cease to be legal Standards;

The use of all Troy weights in shops and places where goods are exposed or kept for sale shall be illegal, and all Troy weights found there shall be liable to be seized and forfeited, and the person in whose possession they are found shall, on conviction, be liable to a penalty not exceeding 5*l.*;

All contracts for buying and selling made in terms of Troy weight shall be void;

Such provisions to apply to all weights and measures used for pharmaceutical purposes; and that it be expressly declared that the powers granted under the Medical Act, 1858, to the General Medical Council of regulating the weights and measures to be used in Pharmacy be limited to legal denominations of weights and measures for which Standards are provided by law.

3. We recommend that for a period of 10 years after the passing of the Act, the use of Troy weights for the internal operations of manufactories and workshops not subject to the visits of Inspectors of weights and measures be permitted, and that no contract or agreement between a master and workmen, or between a wholesale and retail dealer, be illegal, in consequence of its being made in reference to Troy weight;

But that after the expiration of 10 years from the passing of the Act, the same provisions shall be applicable to such Troy weights as to those specified in s. 2.

4. Considering,

That the several operations connected with the gold and silver coinage, the purchase of bullion, and the assay of the precious metals are frequently carried on with relation to business transactions with foreign countries, and, as such, are matters of international trade;

That we have had the evidence of the late Master of the Mint, that the substitution of the Metric system of weights for the Troy system, and of the decimal system of assay for the grain and carat system would be attended not only with no difficulty as regards the Mint, the Bank of England, and the bullion trade, but with advantage to the public;

That, from the evidence produced before us, we have reason to believe that no valid objections or practical difficulties exist to such substitution;

We recommend that legislative provision be made that, in all cases where specified weights of the Troy system are recited in any existing Act of Parliament, and relate to the weight or fineness of the gold or silver coinage, or of bullion, the nearest equivalent Metric weights, according to a Table of Equivalents to be contained in a Schedule annexed to the Act, be substituted.

And we also recommend that in all statements of assays of gold and silver bullion, upon which any legal contracts can be based, the millesimal or centesimal system of assay be substituted for the grain and carat system.

5. Whereas it has been shown to us that the full legal weight of the sovereign very nearly agrees with eight grammes of the Metric system, which agreement may be made sensibly exact, with a convenient millesimal statement of fineness (915·3 instead of 916·66, the millesimal equivalent of $\frac{11}{12}$), by the small addition of 0·01193 grains to the alloy; and that a similar addition of 0·227 grain to the alloy of the shilling (entailing a corresponding change in the statement of fineness of 922·605 instead of 925, the millesimal equivalent of $\frac{222}{240}$), would enable a pound Avoirdupois of standard silver to be coined into 80 shillings, under the same conditions that a pound Troy of standard silver is now coined into 66 shillings;

23RD MEETING, 21 Dec. 1869.

Under other circumstances we should have been disposed to recommend the adoption of these alterations, for the reasons stated by the Astronomer Royal in his memorandum of 18th June 1869. But as it might be considered inexpedient to make any temporary change in the established weight of the coinage at the present period, when far greater changes, both of the weight and standard fineness of our coinage, are seriously contemplated, with a view to the more important object of the establishment of an international system of coinage, we merely call attention to these suggestions as deserving notice.

6. With regard to the Troy weights specified in the Statutes relating to duties on gold and silver plate, and on licences for dealers in gold and silver plate,—

We think that it may be sufficient that due legislative provision be made to enable the Inland Revenue Department to substitute either Imperial or Metric equivalents, or the nearest integral equivalents that may be deemed expedient, until such time as a legislative change may be made in the amounts of these duties for fiscal objects.

In the assessment of Custom duties on gold and silver plate imported into this kingdom from other countries, we recommend the substitution of similar equivalents of Metric weight.

7. *As to the weights to be substituted for those of the Troy system now used by the general public, and for purposes of manufacture and trade.*

Considering,—

That we have stated our opinion in our Second Report that the general introduction of the Metric system should be permissive only, and not made compulsory by law after any period to be now specified, so far as relates to the use of Metric weights for weighing goods for sale or conveyance; and that authoritative regulations should be established by which each series of weights may be readily and easily distinguished by the adoption of conspicuous distinctive forms or otherwise;

That it will be a sufficient hardship upon those persons who now use Troy weights to be compelled to give them up, although for the general advantage of the public, and it will be manifestly unjust also to compel them to substitute Metric weights whilst all other classes of the community are under no obligation to abandon their Avoirdupois weights, and are allowed the option of using Metric weights;

That the grain and its multiples and parts, formerly weights of the Troy system, were made Avoirdupois weights, by the provisions of ss. 3 and 4 of the Act of 1853, for legalizing the restored Standards of weights and measures, and will in future be legal weights of the Avoirdupois scale only;

That a decimal series of grain weights has been recommended in our First Report to be legalized as official Standards; and such series from 0·01 grain to 1,000 grains, and additional weights of 2,000 and 4,000 grains have been constructed, and have been most accurately verified in the Standards Department in order to serve as legal Standards, and for verifying copies for the use of local Inspectors of weights and measures, in order that the public may be supplied with weights of this description duly correct;

It appears to us that upon the abolition of Troy weight, all those persons who now use it, either for manufacturing, trading, or other purposes, should be permitted to substitute either Avoirdupois or Metric weights, and that every facility should be afforded to them for this object;

That for all ordinary purposes the substitution of the Avoirdupois pound, ounce, and dram, with their multiples and subdivisions to the half dram, will suffice for those persons who may wish to substitute the Avoirdupois scale;

That for all such persons who may require more minute accuracy in their weighings, the use of the series of decimal grain weights will meet their requirements;

23RD MEETING, 21 Dec. 1869.

That such grain weights for public use should be constructed of a distinctive form or material, so as to be readily distinguishable from other nearly equivalent weights.

8. With respect to further binary subdivision of the Avoirdupois dram to $\frac{1}{16}$ part proposed for consideration by the Astronomer Royal in his memorandum of June 1, 1869, as useful for the more minute weighing of gold,

> We are of opinion that if it should be hereafter found that such additional weights are needed, they should be legalized, and the requisite Standards provided; but no sufficient evidence has been produced before us to show that such weights are actually wanted, or that if provided they will come into general use.

9. We are of opinion that any legislation for carrying into effect the objects of these resolutions should be comprehended in the Bill to be proposed to Parliament by the Executive Government, for the Amendment of the Weights and Measures laws, as recommended in our Second Report.

The Commission concurred with the proposition of the Chairman, that these resolutions should form the substance of their Third Report, and it was left to the Warden to consult with the Chairman, and to prepare a form of Report for his approval, and for the signature of the several members of the Commission. The proposal of the Warden that all the Minutes of Evidence given before the Commission should be appended to this Report, was agreed to.

6. The Chairman read the unofficial correspondence between himself and the Deputy High Steward of Westminster, relating to the very discreditable state of the office of the Inspector and Sealer of Weights and Measures at Westminster, consequent upon the inspection by the Commission of this office, as stated in the Minutes of the 20th Meeting on 11th August 1869. The Chairman was now assured that his representations should be duly attended to, and proper accommodation be provided for transacting the business of the office, and the subject had with this view been brought under the notice of the Middlesex magistrates, who it was considered were the proper authorities to remedy the existing state of things.

The Commission expressed their satisfaction at this result.

7. The Warden read the correspondence relating to the Austrian Standard Klafter requested for the Standards Department, including a letter from Professor Starke, of the Vienna Polytechnicon, and the despatch from the Imperial Ministry for Foreign Affairs at Vienna to the Earl of Clarendon, communicated through the Board of Trade, in which the Austrian Government greatly regretted that they were unable to accede to the request of Her Majesty's Government, in consequence of being informed by the Imperial Ministry of Commerce that the Klafter measure at present in use does not possess the required accuracy, and that the preparation of one of these measures would take a considerable time.

8. He also read the correspondence with Mr. Oertling and Messrs. Chance, of Birmingham, relating to the experimental construction of glass standard weights, in which Messrs. Chance stated their readiness to co-operate with Mr. Oertling, to whom the necessary directions had been given.

9. The letter from the Board of Trade of 29th November, enclosing copies of the following two resolutions of the Chambers of Agriculture, at a council meeting of the Central Chamber, were read by the Chairman:—

1. That in the opinion of this Council all agricultural produce should be sold only by weight.

2. That the cental of 100 lbs. should be the standard.

The Chairman said that two expressions of opinion in relation to this subject were to be found, one in Appendix § O. to the Report of the Standards Commission of 1841, being contained in a letter from Mr. Biddell, a farmer in Suffolk; the other, in his often quoted letter to the Comptroller General of the Exchequer, of 9th February 1859, printed for the House of Commons in 1859 (No. 188), and also as Appendix No. 4 to the Report of the Weights and Measures Committee of 1862. He read his remarks contained in § VI. of this last letter, "On the proper criterion "in the sale of corn, and the policy or impolicy of the "interference of the Government," and said he was quite sure that it expressed the course that ought to be taken by the Government and the Legislature. He was entirely of opinion that no action on the part of the Commission was called for.

The Warden said it was desirable to bring the opinion of the Astronomer Royal, which appeared to be also that of the Commission, under the notice of the Board of Trade.

23RD MEETING, 21 Dec. 1869.

10. The Chairman then referred to the question of the site for public standards at length. Since the last meeting of the Commission, he had carefully inspected the space of ground on the south side of the Victoria Tower, in company with his son, who has much experience in the use of surveyors' chains, and both had come to the conclusion that no fitter site could be chosen. He thought that it would be best for the Commission to pass a formal resolution to that effect, and he accordingly proposed the following resolution for their approval:—

Considering that the Commission have in their First Report recommended the construction of new standard measures of length, viz.—

The chain of 100 feet, divided into feet,
" " 66 feet, or 22 yards, divided into links,

and other smaller measures; and have resolved at their sixth meeting, on 10th July 1868, that such should be constructed as mural or public standards, the preferable site being the inclosed space on the south side of the Victoria Tower;

That in their Second Report (s. 6), they have also recommended that mural standards of the metric system, as well as of the Imperial system, be exhibited in public places;

That with respect to the best site to be selected for such public standards,—

They should be placed where they are easily accessible to the public who may wish to compare their measures;

Where such comparisons may be made without their being disturbed by passers by or idle gazers;

Where sufficient protection from wilful damage may at all times be secured;

And where there is a long and level plot of ground upon which the longer standard measures may be laid down, with an adjacent wall for the mural standards;

> We are of opinion, after having satisfied ourselves by personal inspection, that there is no site so fit and convenient in every respect for the purpose as that known as the South Return of Victoria Tower;

The Warden of the Standards is therefore requested to move the Board of Trade to invite the assent and co-operation of the Office of Works for the placing of such public and mural standards of Imperial and Metric weights in this spot for the use of the public; and he is also requested, at the same time, to supply the necessary details upon the subject, as agreed upon by the Commission, for the information of the Board of Trade and the First Commissioner of Works.

The Warden is also authorized to give such directions to Messrs. Troughton and Simms as may be required for the construction of such standards, and for co-operating with the workmen to be employed by the Office of Works in the position assigned for them; the providing, working, and fixing the stones being left to the Office of Works.

We propose that the mural standards of the following Imperial measures of length, marked in gun metal upon an iron frame of the dimensions of about 4 feet by 2 feet, be securely fixed to the wall on the right-hand side, immediately within the iron gates,—

Yard,
2 feet, and 1 foot,
6 inches, 3 inches, and 1 inch;

That similar mural standards of Metric length be fixed to the wall on the left-hand side inside the gates—

Metre, and half metre,
Decimetre and half decimetre,
Centimetre;

That mural standards of 10 feet and 6 feet be placed against the south wall;

And that public standards of surveyors' chains in accordance with the plan submitted to the Commission by the Warden of the Standards, be laid down midway between the curbstone and the wall on the right-hand side, parallel to the south front of the Houses of Parliament.

We beg to express our hope that the Board of Trade and the First Commissioner of Works will concur in carrying out this proposal, which we believe will be found to be of much advantage to the public. When completed, these public standards may be placed under the charge of the Office of Works, like other public monuments in the Metropolis; and it would be desirable that a communication should be made by the Office of Works to the Chief Commissioner of Police, with a view to the greater security of the standards,

23RD MEETING, 21 Dec. 1869.

and that regulations should be issued for admitting the public to compare their measures at convenient hours of the day.

This resolution was carried unanimously, and it was left to the Warden to take the necessary steps with a view to its being carried out.

11. The Warden called the attention of the Commission to the balances used in the Department for the comparison and verification of local standard weights.

He referred to the statement in his Report on the Exchequer Standards, dated in 1863 (p. 30), that the balances constructed by De Grave and Co. in 1825, and since used in the Department, were declared in 1854 by the Astronomer Royal, Sir J. Herschel, and Professor Miller, to be by no means fit for their purpose, being of an antiquated character, and essentially inaccurate for standard weighings; they considered that they should be replaced by at least four, if not five, entirely new balances of the finest construction; and four new balances were accordingly furnished by Messrs. Ladd and Oertling, to be used for the weighings requiring special precision.

Up to last year, however, the new balances were used only for comparisons with the bullion standards, and for reverifying the official standard weights, and the old balances continued in use for comparing copies of the Avoirdupois standards for the local Inspectors of weights and measures.

But when a definite scale of errors to be tolerated was recommended by the Commission in their First Report, and was sanctioned by the Board of Trade in their official letter of 11th September 1868, and directed by the Warden in his Minute of 14th September, to be acted on in the departmental comparisons, it became impossible to continue the use of the old balances, as they do not show with sufficient exactness the difference of weight in the standards compared; and since this period the fine balances constructed by Oertling have been unavoidably used for all official comparisons of local standard weights, although it somewhat distresses the largest of these balances, constructed for the maximum weight of 500 ounces in each pan, to charge it with 56 lb. standards.

The new room in the basement of the Tower is now nearly completed for official use as a weighing room, where the finest balances will be placed, and used exclusively for weighings requiring the greatest precision, and for scientific purposes. In this room it is proposed to place the following balances:—

Oertling's balances, Nos. 1, 2, 3, and 4, constructed in 1855.

Oertling's large balance, with a mahogany beam, for weighing the standard bushel filled with water, being a reconstruction of Kater's balance by Oertling in 1867, at a cost of 182*l.*, including 40*l.* for the glass case.

Barrow's balance, used by Professor Miller in his weighings during the construction of the standard pound, and now transferred to this Department.

Two new balances recommended by the Commission to be constructed by Oertling, viz.—

One for weighing kilograms (No. 5).

A vacuum balance for weighing in vacuo or rarified air.

The Warden stated that the kilogram balance was wanted immediately, and he had, therefore, directed Mr. Oertling to furnish it at once. He had also requested Mr. Oertling to consider how the vacuum balance could best be constructed, that he might be fully prepared to proceed with the work, as soon as the official order was given for its construction.

But all the ordinary departmental comparisons of local standard weights must continue to be made in the old weighing room No. 16, which is very convenient for the purpose, being close to the entrance of the office and to the messenger's room, where the many heavy local standard weights are first deposited. The floor of the room No. 16 has also been specially strengthened for the support of heavy weights.

It has thus become absolutely necessary to condemn the four old balances, and to replace them by others which may be serviceable. The following are the imperfections of the old balances:—

(1.) The knife edges do not work upon a plane, but upon a curved surface, like ordinary balances, and are consequently wanting in precision.

(2.) The weight of the beam, and of the chains, &c. for the pans, always rests upon the knife edges, instead of a supporting bar, when not required to be in action.

23RD MEETING, 21 Dec. 1869.

The only index is a short pointer, without any graduated scale. It does not indicate any minute difference, such as is now required.

(4.) The beam is of iron, and subject to be affected by magnetic influences.

(5.) The pans are suspended by brass chains, and the balance is consequently less steady than if rods were used.

Four new balances are now required of improved construction, but probably not quite so costly or so finely constructed as those by Oertling, viz.:—

No. 1, for comparing Imperial weights		56 lbs. to 14 lbs.
or Metric	,,	20 kilo. to 5 kilo.
No. 2, for comparing Imperial	,,	7 lbs. to 2 lbs.
or Metric	,,	2 kilo. and 1 kilo.
No. 3, for comparing Imperial	,,	1 lb. to 2 oz.
or Metric	,,	500 grammes to 50 grammes.

No. 4, for all smaller weights.

The original cost of the four fine balances of these sizes, the knife edges of the two larger working upon steel planes, and of the two smaller on agate planes, together with their plate glass cases, as furnished by Messrs. Oertling, was 173*l.*

The old cases will remain serviceable for the three largest new balances by substituting better frames of plate glass for the ordinary sash frames which now form the fronts of the cases. Messrs. De Grave, who originally supplied the old balances, and have always been employed to keep them in repair, have, on being requested, given the following estimate for new balances of improved construction:—

"No. 1. Balance with 40-inch beam of gun metal to carry 56 lbs., the beam supported at three points while at rest, and fitted with cam and lever motion to supporting slide; the pans to be 11-inch diameter suspended by rods, with smaller pans placed above. £63.

"No. 2. Balance with 24-inch beam of similar construction to No. 1. £32.

"If the beams of the above are made of mahogany, we believe the cost would be the same as if made of gun metal.

"No. 3. Balance with 16-inch beam to carry 1 lb., mounted on a slab to stand in glass case. £15.

"No. 4. Balance with 10-inch beam to carry 1 oz. in lantern. £14. 10*s.*

"Fitting the three glass cases with new mahogany sashes and plate glass, painting and graining the frame around. About £28.

"With respect to the three old pairs of scales, they were made 45 years ago for a special purpose, and are therefore unsuited for commercial use, and in all probability we should never find any one to purchase them; under these circumstances we cannot offer more than £10.

	£	*s.*	*d.*
	63	0	0
	32	0	0
	15	0	0
	14	10	0
	28	0	0
About	152	10	0
Deduct for old scales	10	0	0
	£142	10	0

"DE GRAVE, SHORT, AND FANNER.

"59, St. Martin's-le-Grand,
20th December 1869."

The Commission having inspected the old scales, the Chairman and Professor Miller agreed it was quite obvious that new scales must be provided for the Department, and the Commission authorized the Warden to take the necessary steps for that purpose, approving of the estimate sent in by Messrs. De Grave and Co.

12. A specimen Metric weight of 500 grams, made by Messrs. De Grave and Co., accordingly to Professor Miller's suggestion, of a cylindrical form, without a knob, and with a groove around the cylinder at half the height, was exhibited to the Commission. Professor Miller said he would prefer a more shallow groove at about one-third of the height of the cylinder from the top; and the Warden undertook to give directions accordingly.

13. Specimens of cylindrical glass measures of capacity of 10,000 grains of water, one fluid ounce, and one cubic inch, with their respective decimal parts marked upon them, were exhibited to the Commission.

Professor Miller said that the defining lines should be marked upon both sides of the cylinder, in order that the measure might be taken with accuracy.

The Warden said these were only specimens of ordinary

23RD MEETING, 21 Dec. 1869.

measures, such as were sold to the public. He proposed to communicate with Mr. Griffin, for the purpose of obtaining the most accurate glass measures of this description for the Department. They were required in the comparison and verification of the local standard measures of capacity, and would be carefully verified.

14. In reference to the cubic foot measuring apparatus designed by Mr. Sugg, and left for consideration at the 19th meeting of the Commission, the cost being 40*l.*, the Warden said this apparatus was immediately required for the reverification of the gas-measuring standards. This apparatns was now used by the metropolis gas referees, and the following appeared to be its advantages as compared with the cubic foot apparatus hitherto used in the department:—

1. More exact measurement is attained, from the upper part of the neck of the cubic foot bottle being a graduated glass tube of ¾-inch in diameter.
2. More uniform temperature is maintained during the displacement of the air from the interior of the cubic foot, by the exterior of the bottle being kept dry instead of *wet* as in the present apparatus, and the temperature of the displaced air is consequently more readily ascertained.
3. The air is more gently displaced, no manual labour being required, as in the raising of the large cistern of water in the present apparatus.
4. The metal of Sugg's cubic foot bottle is similar to that of the gas-measuring standards, and thus any variation of volume is avoided which might otherwise occur.

The Chairman said that the Department should be provided with the very best instruments for making comparisons with the greatest accuracy, and the Commission agreed that this apparatus ought to be immediately procured for the use of the Department.

15. The Warden reported to the Commission that directions had been given to the Queen's Printers to proceed with the printing of the several papers to form Appendices to the Third, Fourth, and Fifth Reports of the Commission.

16. He also mentioned that he had had a visit from one of the firm of Messrs. Pooley, makers of large weighing machines at Manchester, who quite approved of the testing of such weighing machines by the Inspectors, and of making all the special weights of legal denominations. He had also suggested the expediency of making a definite allowance of error in the case of large weighing machines, as was the case in France, it being impossible that they should be found to be minutely accurate.

The Commission thought this suggestion deserving of consideration.

17. With regard to the question of the new foreign postal weights, the Warden reported that the Board of Trade had informed the Postmaster General on 2nd December, that the subject had been referred to the Standards Commission; and an officer from the Post Office called upon him on the 4th December, to ask for an early decision of the Commission, as it was wished to bring the postal convention with France into operation as soon as possible. At his suggestion, therefore, his report to the Board of Trade, including the Astronomer Royal's remarks, and the opinion of the Commission as expressed in ss. 27, 28 of the minutes of their meeting of 19th November had been at once sent by the Board of Trade to the Postmaster General for any observations upon them. He had also informed the Board of Trade that the Commission would be prepared to pass a formal resolution on the subject, when they were informed of the views now taken by the Post Office, and of the exact terms of the new postal convention with France; and that if this information were furnished to them in time for the meeting this day, they would take it into immediate consideration. He had not heard anything further on the subject, but it might happen that on receiving the reply from the Post Office the Commission would be asked for an early decision.

The Chairman did not think a special meeting of the Commission would be required for this question of the Post Office weights. The Warden was entirely in possession of the views of the Commission respecting it, and might be prepared to act upon them.

18. The Warden said that he had nearly completed his final paper upon the question of the inspection of weights and measures, including resolutions proposed for the consideration of the Commission, when the subject would be quite ready for their decision, so that it might form the basis of the Fourth Report. He hoped that they might meet again for this purpose before the end of January.

It was left to the Warden to arrange accordingly with the Chairman for their next meeting.

The Commission adjourned at 3 p.m.

G. B. AIRY,
Chairman.

TWENTY-FOURTH MEETING.—SATURDAY, 2nd APRIL 1870, at 11 a.m.

24TH MEETING, 2 April 1870.

PRESENT:

The Astronomer Royal (Chairman).
The Lord Colchester.
The Right Honourable Stephen Cave, M.P.
Sir J. G. Shaw Lefevre, K.C.B.
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The minutes of the 23rd meeting were confirmed.

2. The Warden laid before the Commission the following printed papers:—

Continuation of III.–VI., relating to the proposed standard weights of ⅓ and ⅔ oz. for foreign postal services.

III.–VII. On the working of the Sale of Gas Acts, and inspection of gas meters.

XIV.–I. On the inspection of weights and measures, with revised form of resolutions.

XVIII. On the reverification of the official standard measures of capacity.

XIX. On the reverification of the official standard yard, with other comparisons of imperial standard measures of length.

XX. On the reverification of the gas-measuring standards.

XXI. On the standard weights and measures of the United States of North America.

XXII. On the carrying out of the provisions of the Coinage Act, 1870.

Copy of the Coinage Bill, passed by both Houses of Parliament.

Appendix to 4th Report, pp. 1–248, revised for press.
,, 5th ,, 1–56 ,,

The Warden stated that Paper X.–II., containing the completion of the verification of the Imperial standard weights, was now in MS., and ready for the printers.

The Chairman said that the business of the Commission appeared to be in a progressive and satisfactory state.

3. The following standards, &c. were exhibited to the Commission:—

Three weights of ⅓ oz. and of ⅔ oz. respectively, constructed by Messrs. De Grave.

A set of brass metric standard postal weights from Berlin, from 500 grammes to 1 milligram.

Two sets of glass metric weights, adjusted with mercury, from a kilogram to 1 milligram, constructed by Salleron, of Paris.

A newly constructed iron 56 lb. weight, of brick form, presented by Messrs. Pooley, of Manchester.

Specimens of the new glass weights now being made by Messrs. Chance and Mr. Oertling.

Specimens of coin weights, sent for inspection by Messrs. De Grave and by Mr. Oertling.

Specimens of new glass measures of capacity, with burettes and stand, constructed by Messrs. Griffin.

Grooved bar, of Baily's metal, with brass slider, marked with graduated measures of a foot and decimetre and subdivisions, constructed by Messrs. Troughton and Simms.

Specimens of figures designed by Colonel Strange, and engraved with revolving drill apparatus.

Two calculating rods for corrections of temperature and pressure in comparisons of gas measures, by Salleron, of Paris.

Two new brass copies of the Astronomer Royal's gauging rod, made by Messrs. Vandome, similar to a copy made for the Island of Granada.

4. As to the question of the construction and legalization of standard weights of ⅓ and ⅔ oz. for foreign postal services, the Chairman read the letter from the Postmaster General of 27th December last, and the remarks of the Warden of the Standards, contained in the continuation of Paper III.–VI., as well as the further letter of the Secretary of the Post Office, dated 25th February 1870, in reference to a standard weight of ⅔ oz. He then proposed the following resolution, which was unanimously agreed to:—

The Standards Commission have fully considered all the circumstances relating to the question of legalizing a standard weight of ⅓ oz., as contained in Paper III.–VI. delivered by the Warden of the Standards.

Looking upon the question as connected with the standards of weight generally, the relation of the several parts of the avoirdupois scale to each other, and the near prospect of establishing the metric system as an international system of weights and measures, they continue entirely to concur with the views expressed by the Astronomer Royal and the Warden of the Standards in the remarks transmitted to the Board of Trade on the 10th November last.

The Postmaster General has however expressed his inability to acquiesce in these views, and has urged that the adoption at the present time of the 10 gramme weight, as a unit for foreign postal rates, is open to most serious objections in regard to the administration of the department with which he is charged. And Lord Hartington is supported in this opinion by the high authority of the Treasury.

At the same time the legalization of a standard weight of $\frac{1}{3}$ oz. for foreign postal services is advocated both by the Post Office and the Treasury as a *temporary arrangement* only, and without any reference to the larger and more important question of the use of the metric system of weights by the Post Office.

The Standards Commission cannot admit the conclusiveness of the reasons urged by the Postmaster General in favour of legalizing a $\frac{1}{3}$ oz. standard weight, nor against the adoption of a 10 gramme weight. They observe also that these reasons are based upon the proposed ultimate adoption of a $\frac{1}{2}$ oz. weight as the unit of international postage between Great Britain and France. But as the determination of the question now appears to rest only upon Post Office departmental grounds, involving also the interests of the public to a considerable extent, of which the Post Office authorities and the Treasury may be allowed to be more competent judges and have taken upon themselves the responsibility, the Standards Commission are of opinion that it is not within their province to interfere with what more immediately concerns the internal administration of the Post Office Department, and their arrangements for Conventions with foreign Governments, and that it will be for the public advantage that the request of the Postmaster General and the Treasury be at once complied with and the necessary steps taken for the construction, verification, and legalization of a $\frac{1}{3}$ oz. standard weight as a temporary arrangement.

The Postmaster General has further requested that a standard weight of $\frac{2}{3}$ oz. be also constructed and legalized, Post Office weights of $\frac{2}{3}$ oz. being required, as without such weights there would be a great loss of time in weighing letters.

They therefore recommend,—

1. That standard weights of $\frac{1}{3}$ oz. and $\frac{2}{3}$ oz. for foreign postal services be immediately constructed and verified, under the directions of the Warden of the Standards, with a view to such weights being constituted legal secondary standards under the provisions of s. 6 of the Standards Act, 1866.
2. That such is to be understood as a temporary arrangement only, until the whole question of the introduction of the metric system of weights and measures into this country, and the more limited question of the adoption of metric weights for Post Office services, be determined by Parliament.
3. That in any legislative measure to be submitted by Her Majesty's Government to Parliament for amending the laws relating to weights and measures, provision be contained that the 10 gramme weight be substituted for $\frac{1}{3}$ oz. as a unit for foreign postal services, at the earliest period at which the necessary arrangements for that purpose can be made by the Post Office authorities.

5. The following weights of $\frac{1}{3}$ and $\frac{2}{3}$ oz. which had been constructed in Baily's metal by Messrs. De Grave, and verified in the Standards Department, the comparisons of which will be shown in Paper X.-II., were then inspected by the Commission:—

——	Standard Weight.	Ascertained Error.
	grains.	grains.
$\frac{1}{3}$ oz. No. 1 -	=145·82754	or −0·00579
„ No. 2 -	=145·82825	−0·00508
„ No. 3 -	=145·82802	−0·00531
$\frac{2}{3}$ oz. No. 1 -	=291·65850	−0·00816
„ No. 2 -	=291·65472	−0·01194
„ No. 3 -	=291·65697	−0·00969

The Chairman objected to the form of these weights, being flat cylindrical weights with a groove round the cylinder, such being the distinctive form which had been approved by the Commission for metric weights. The Warden accordingly undertook to have an additional weight of each denomination constructed without such groove, in order that they might be constituted standards, and he stated that the weights now verified would be available as auxiliary standards or counterpoises for departmental comparisons. This course was approved by the Commission.

6. Colonel Strange's figures, which were also referred to in Paper XXII., were approved by the Chairman and by Professor Miller. The Chairman stated that similar improvements had already been made in the figures in the Nautical Almanack and in recent books of logarithms, with the addition of a slight alteration in the figure 9, so as to distinguish it from the figure 6 when reversed. In arranging the type for the figures of the Greenwich Observations, he had thought it desirable they should be made in some degree similar to those in ordinary manuscript, the figures 5 and 6 rising above, whilst 7 and 9 ranged below the others.

The Warden said that these figures were proposed to be used with the revolving drill apparatus, and for this purpose it was a much more convenient arrangement that all the figures should be of the same size. He had been told by Mr. James Simms that a revolving drill apparatus for engraving somewhat similar figures was constantly used in their factory at Old Charlton, and he proposed to go and see it, with a view to the construction of a similar apparatus for the Standards Department. This apparatus was upon the same principle, that of the pentagraph, with the addition of a wheel and crank moved by the foot, as the apparatus used by Colonel Strange. He had received from Mr. Grubb, of Dublin, a drawing and descriptive account of the revolving drill apparatus constructed by him, and used for marking the constabulary arms in Ireland; but it appeared to him that Messrs. Troughton and Simm's apparatus would be more suitable for the requirements of the Standard's Office. He would report further upon the subject to the Commission at a future time.

7. As to the new glass weights sent by Mr. Oertling, which were not yet adjusted, Professor Miller approved of the general form and appearance. He would like to know the exact composition of the glass from Messrs. Chance, and thought that if the neck were more rounded, so as not to hold dirt, it would be an improvement.

The Warden said he had been making inquiries as to the best mode of marking glass weights and measures. Mr. J. Simms had informed him there would be no difficulty in marking them by means of a hard drill, if the surface of the glass were moistened with spirits of turpentine. They could also easily be etched with hydrofluoric acid, put on with a small brush, if the glass had a slight covering of wax, with the design traced upon it. He thought this method might be found more convenient of application than using the fumes of the acid. For both these methods, a uniform design could be traced with a revolving drill apparatus.

The Chairman and Professor Miller agreed that either of these methods might be advantageously adopted, and that it might be left to the Warden to determine the most convenient mode.

8. With respect to Paper XX., on the reverification of the gas-measuring standards, in which a full account of the details of the observations would be found, the Warden said this reverification had been completed by Mr. Chaney, so far as the departmental instruments would now allow. At present no greater error than 0·01 cubic foot could be noted on a single observation; but he hoped on a future occasion by using instruments of greater accuracy, which were now being constructed, that far greater precision might be attained. The authorized tolerance of error in the comparison of copies of the gas-measuring standards is now 0·5 per cent., both in excess and in deficiency. The *mean* errors of the gas-measuring standards from several observations have been found to be as follows:—

Denomination of Gas Measuring Standard.	Mean Error.	
	Error of Standard.	Error per Cent.
	cubic foot.	
10 foot gas measurer -	−0·02590	0·00259
5 „ „ -	−0·00667	−0·00135
1 „ „ -	−0·00053	−0·00053

24TH MEETING, 2 April 1870.

The Chairman expressed his great satisfaction at the near approach to perfect accuracy exhibited in these results of the reverification of the gas-measuring standards.

9. In calling attention to Paper XXI. on the Standard Weights and Measures of the United States of North America, the Warden said that he had just received a letter from Mr. Motley, the United States Minister in this country, conveying through the Secretary of State at Washington, the thanks of the head of the Standards Department for the information contained in the Commission papers transmitted to him, more particularly those relating to the proposed International Commission at Paris, which had facilitated the arrangements at Washington for sending representatives to the Paris Commission, and thus accepting the invitation of the French Government.

10. The Warden reported the several proceedings relating to the decision of Her Majesty's Government in relation to the proposed International Commission at Paris. The first intimation received either by the Board of Trade or by himself was a letter from General Morin, dated 16th March 1870, stating that the British Government had officially declined sending any representatives, to Paris, on the ground that the metric system was not in use in this country. General Morin at the same time pointed out how injurious might be the result of this decision, if persevered in, upon the interests of science and the progress of civilisation, and expressed a hope that steps should be taken to have the decision reconsidered. He had immediately communicated General Morin's letter to the Astronomer Royal, as well as to the Board of Trade, who had strongly recommended to the Treasury that the recommendations of the Commission should be carried out. Mr. Lefevre requested him to draw up a paper of reasons why the Government should reconsider their decision, and this paper he accordingly furnished. (A copy of this paper, dated 23 March, was laid by the Warden before the Commission.) On the following day, he received a private note from Mr. Lefevre to say that the Chancellor of the Exchequer had reconsidered his decision, and had agreed to appoint two Commissioners to represent this country, the Astronomer Royal and Professor Miller. It appeared upon further inquiry, that Mr. Lowe objected to nominate more than two members to the Paris Commission, in which he considered that this country was not directly interested. The Warden added that he had immediately pointed out that his own appointment had also been recommended by the Commission, and that there was much detailed work requisite to be done, which it was not to be expected the Astronomer Royal or Professor Miller would undertake, whilst it was of material importance that both should be members of the Commission. The Board of Trade entirely concurred in this view, and a fresh representation had been made to the Chancellor of the Exchequer, but no reply had yet been received.

The Astronomer Royal said that in any event he could attend at Paris only for the purpose of stating his views upon the more important points; and Professor Miller added that he could not undertake, without the assistance of Mr. Chisholm, the various detailed duties required to be performed in the observations and comparisons of standards, and reporting the proceedings.

11. The Commission took into consideration Paper XXII., on the carrying out the provisions of the Coinage Act, 1870, relating to standard weights for coins. In placing before them copies of the amended Bill, which has now passed both Houses, the Warden said that he had been consulted as to the provisions relating to standard weights, some of which were altered according to his suggestions. He had since been consulted by Lord Lansdowne, who had charge of the Bill in the House of Lords, as to the inspection of weights used for coins, and, upon looking further into the subject, he had furnished his Lordship with the information contained in Paper XXII. It appeared, however, that no question was raised in the House as to the standard weights for coins or their inspection, and no alteration was made in this respect in the Bill.

The Chairman read the clause of the Coinage Bill imposing a penalty of 50*l*. upon any person using an unstamped weight for coins, and remarked that it was a very serious matter that a tradesman should be thus fined for the common practice of using glass weights to weigh sovereigns and half-sovereigns, such weights never having been stamped.

The Warden showed that under s. 17 of the Coinage Act the Board of Trade were required to construct 16 standard weights of the several coins specified in the first schedule. He proposed at once to give directions to Mr. Oertling for their construction. Upon the mode of their construction he wished to have the opinion of the Commission. As for the metal to be used, brass had been condemned for standard weights in consequence of its variation from oxydation, and Baily's metal had recently been substituted. Experience had, however, lately shown that a certain amount of increase in weight also occurred from oxydation in Baily's metal; and upon this ground he suggested that it might be expedient to make the new standard weight of a sovereign of standard gold, minute accuracy in the weight being requisite.

Professor Miller said that Baily's metal was selected rather from its rigidity, which was required in standard measures of length, than from its applicability to standard weights. A distinctive metal was evidently required in these coin standards. The standard weight of each was specified in the schedule to the Coinage Act, and there was a difference of less than a quarter of a grain between the weight of a silver shilling and a bronze halfpenny, and less than an eighth of a grain between the weight of a sixpence and a farthing.

The Chairman considered that sufficient reason had been assigned for making all the standard weights for gold coin of standard gold. The form of all the coin standard weights might be similar to those now used at the Mint. The Commission concurred in this opinion.

12. The Warden said that a further question arose as to the multiples of coin weights required. It was evident that multiples of the weight of the sovereign only could possibly be required, these being extensively used by bankers, though not stamped. The Commission have already resolved that standard weights, being decimal multiples of the full weight, not the least current weight, of the sovereign should be established, and a recommendation to that effect was contained in their First Report. It had now become necessary to take action with regard to these questions, as the Coinage Act required the Board of Trade to cause "multiples of "such of those weights as may be required to be made and "duly verified." With a view of ascertaining what standard weights of multiples of the sovereign were actually wanted, he had written to Mr. Forbes, the chief cashier of the Bank of England, for information. He read Mr. Forbes's reply, stating that in his opinion no such standard weights were required; that the Bank of England did not use such weights; and that bankers who did use them required them only to check the number of sovereigns, and in no way to determine their just weight. Again, he had inquired whether the Mint used such weights, and Mr. Freemantle had replied that they were not used at the Mint. Under these circumstances, he wished to have the opinion of the Commission for his guidance and for the information of the Board of Trade. He had ascertained that these multiple weights actually used by bankers were neither the full legal weight of sovereigns nor the least current weight, but the mean weight, considered to be the average weight of sovereigns in calculation. He had obtained a brass weight of 100 sovereigns now in use by his own bankers, and tested its weight by weighing it in the Standards Department, and he called attention to the following tabular statement:—

Full legal weight of 100 sovereigns - -	12327·447 gr.
Least current weight -	12250·
Mean weight - -	12288·7235
Average weight adopted for bankers' weights by Messrs. De Grave, Mr. Oertling, &c. - -	12289·
Actual weight of a banker's 100 sov. weight - -	12244·7

Under these circumstances it would appear that standard weights of the decimal series of multiples of the full legal weight of the sovereign were really not required, and that if it should be deemed expedient to construct any standard weights they should be of the mean weight between the full and the least current weight. He would, however, suggest that he should be instructed to write to Sir John Lubbock, who he was informed was secretary to the Committee of Bankers, for further information upon this point.

The Chairman said that it was obvious these multiple weights could not be of any use in determining the justness of weight of any single sovereign. He was of opinion that the Committee of Bankers should be consulted before any decision was given by the Commission.

Lord Colchester suggested that it should be ascertained whether Sir John Lubbock could state the wishes of country as well as London bankers, and it was left to the Warden

24TH MEETING, 2 April 1870.

to obtain information upon these two points, and to report to the Commission at a subsequent meeting.

13. The Chairman pointed out the statement in Paper XXII. of the satisfactory announcement of the Governor of the Bank that the millième report of assays had been adopted at the Bank instead of carats and grains. He could not however see the advantage of the assay being carried to $\frac{1}{3000}$th part.

14. As to the question of laying down public and mural standards of length on the South side of Victoria Tower, which had been referred to the Office of Works, the Chairman explained that the First Commissioner of Works had written to the Board of Trade to state that more ground was being purchased there, and that the laying down public standards would interfere with any future disposition of the ground. For this reason it was suggested that a more eligible site might be found at Somerset House. This letter having been referred to the Warden, the Chairman said that he would take an early opportunity of inspecting this proposed site, and it was left to him to bring the subject before the Commission on a future occasion.

15. The Warden reported that on the invitation of Sir Joseph Whitworth he had attended, together with some of the officers of the Board of Trade, to inspect his comparing apparatus for measures of length, Sir J. Whitworth having stated that he was willing to present his apparatus to the Standards Department if its use were approved. With this object Sir J. Whitworth would be glad to exhibit it to the members of the Commission.

He had also inspected a yard measure constructed as a pendulum, with a suitable comparing apparatus elaborately finished, constructed by Mr. E. D. Johnson, marine chronometer maker to the Admiralty, who wished to present it to the Standards Department, and who invited the members of the Commission to inspect these instruments. These two subjects were left for future consideration.

16. The Warden laid before the Commission a petition from the Inspectors of weights and measures in Shropshire, praying that a recommendation be made for empowering the magistrates to grant them superannuation allowances. He added that this petition had been placed in his hands by Colonel Corbett, M.P. for South Salop, to whom he had explained that the subject was already under the consideration of the Commission.

17. The Commission then began the consideration of Paper XIV.–I. relating to the inspection of weights and measures.

In reply to several questions by the Chairman and other members, the Warden gave explanations as to various details in relation to the proposed resolutions.

The Chairman thought it would be desirable that the resolutions, which involved material changes in the existing system of inspection, should be preceded by a distinct statement of the grounds upon which such important changes were required, and showing in what respects the present practice was insufficient or imperfect, and how the new mode would remedy its defects. After agreeing upon such a preamble, the Commission might proceed to consider the several resolutions in detail.

It was accordingly left to the Warden to prepare such a statement from the papers and evidence now before the Commission, to be laid before them at their next meeting.

18. Some of the members inspected the new weighing room of the Department in the basement of the Tower, and the new commercial standard of length and comparing apparatus now fixed in the room next the gas-measuring standards room.

The next meeting of the Commission was fixed for Saturday next, 9th April, at 11 a.m., for the further consideration of Paper XIV.–I., and the Commission adjourned at 3.30 p.m.

G. B. AIRY,
Chairman.

25TH MEETING, 9 April 1870.

TWENTY-FIFTH MEETING.—SATURDAY, 9th APRIL 1870, at 11 a.m.

PRESENT :

The Astronomer Royal (Chairman).
The Lord Colchester.
The Right Honourable Stephen Cave, M.P.
Sir J. G. Shaw Lefevre, K.C.B.
Professor W. Hallows Miller, F.R.S.
The Warden of the Standards.

A letter from Sir E. Sabine was read, stating that he was prevented by illness from attending.

25TH MEETING, 9 April 1870.

1. The minutes of the 24th meeting, as corrected, were confirmed.

2. The Warden laid before the meeting printed copies of Paper X.–II. on the completion of the reverification of the official standard Imperial weights. He pointed out that Professor Miller's method of determining the specific gravities of standard weights had now been adopted in the Standards Department, having been for the first time employed as stated in this paper. The Chairman observed that the paper contained much useful matter.

3. The new burette stand constructed by Messrs. Griffin was exhibited to the Commission, together with the mode of using it for verifying a standard glass litre measure.

4. In answer to a question from the Chairman respecting the construction and mode of using Sir J. Whitworth's measuring apparatus, the Warden stated that although this apparatus was not at all suitable for the ordinary departmental comparisons of standard measures of length for the use of local Inspectors, it was well adapted for comparing end measures of length for engineering or manufacturing purposes, in which special accuracy was requisite, and also for precise measurements of cylindrical bodies, and for gauging their size. He thought it desirable that for such purposes it should be deposited and adopted in the Standards Department. Professor Miller concurred in this opinion.

5. The two new weights of $\frac{1}{3}$ oz. and $\frac{2}{3}$ oz., intended to be constituted Standard weights for foreign postal purposes, being in substitution for weights of similar denominations submitted to the Commission at their last meeting, were exhibited and approved. The Chairman read a MS. addition to Paper X.–II., which had been drawn up by the Warden, explaining the circumstances under which the two new standard weights were constructed, and showing their mode of verification and its results. The following resolution was unanimously agreed to by the Commission :—

> We have inspected the new Imperial weights of $\frac{1}{3}$ oz. and $\frac{2}{3}$ oz., which have been constructed in accordance with our Resolution of 2nd April 1870, and have been duly verified in the Standards Department, their weight in relation to the Imperial standard pound having been accurately determined. And we are satisfied that such weights are fit and proper to be constituted legal secondary standards under the provisions of § 6 of the Standards Act 1866.

6. With respect to the reverification of the new official avoirdupois standards described in Paper X.–II., the Warden pointed out the increase of weight, attributable to oxydation, which had been observed in the several standard weights since they were first delivered to the Standards Department, comparisons of these standards having been made at different periods for the purpose of ascertaining such increase. He submitted to the Commission the question of the expediency of readjusting such weights to their true standard weight by removing in the Department a portion of the oxydized surface.

Professor Miller said, that as these standards were for practical use, he approved of these weights being rubbed or polished with leather charged with a little rouge or red oxyde of iron, in order to diminish the increased weight, when such increase had been accurately ascertained, and which might arise from oxydation.

7. The Commission took into further consideration the question of the construction of standard weights for coins, required by the provisions of the Coinage Act to be provided for the Standard Department. The Warden reported the result of his communication with Mr. Oertling, as to the metal of which these weights should be made, and their mode of construction. It had been agreed by the Commission, at their last meeting, that the sovereign and half sovereign standard weights should be made of standard gold. He now suggested that the standard weights of two and five sovereigns should be of gilt gun metal. The silver coin standards might be of palladium silver alloy, as a distinctive metal, it being hard and not quickly tarnished. The bronze coin standard weights should be of similar metal to the coins. Three sets of these coin standard weights would be required, according to the established practice in the Department, one set being the standards for reference, the second the official set for departmental comparisons, and the third to be used as counterpoises. It would be sufficient to have the standard set of gold and silver coin weights made of the more expensive metals. These proposals were approved by the Commission.

As to the form of these new standard weights, Professor Miller recommended that the existing form of such weights

25TH MEETING, 9 April 1870.

should be altered in favour of a cubical form, or one that could easily be lifted by forceps.

The Warden considered that with respect to the mode of marking these standard weights, he thought that it would be quite sufficient to mark the value of the coin in an abbreviated form upon their upper surface, for instance, "1 sov.," and upon the gold coin weights to add "full wt." or "least wt."

With regard to the question whether any or what decimal multiples of the gold coin weights were required, the Warden read a letter from Sir John Lubbock, stating his impression that such multiples were used by bankers merely for checking the number of sovereigns. It would therefore now appear that no standard coin weights for such multiple denominations were required, either of full legal weight, or of least current weight.

The Chairman concurred in this opinion, and said that the Commission must abandon their former recommendation for constructing and legalizing standard weights for decimal multiples of gold coins. This was agreed to by the Commission.

8. Upon the question of the nomination of representatives from this country to take part in the International Standards Commission at Paris, the Warden reported that no further communication had been received from the Treasury; but the Board of Trade were strongly pressing the importance of sending the three representatives proposed by the Standards Commission.

9. A letter from Messrs. Chance stating the composition of the glass standard weights manufactured by them was read by the Warden. The glass was made of their ordinary ingredients, silica 72·5 per cent., soda 13 per cent., chalk 13·5 per cent., and the balance of 1 per cent. of traces of manganese and arsenic. The Chairman thought this composition would make good hard glass suitable for durable standards. It was also approved by Professor Miller.

10. The Warden laid before the meeting a copy of a printed report of the Clerk of the Peace for Middlesex, with reference to a letter dated 13th December last, from the Home Secretary to the Chairman of the Quarter Sessions for the county of Middlesex, recommending that instructions be given by the magistrates to inspectors not to seize weights and measures in canteens which were found by them to be defective, but to report them to the War Office to be dealt with by that department; together with the resolution of the Court thereon, "that the Court is of opinion that it is incompetent in the interests of public justice that the suggestion of the Secretary of State be adopted." It appeared that the legal opinion of the Clerk of the Peace was that there was no provision of law to exempt keepers of canteens from the general law relating to weights and measures. The Warden added that these papers had been brought under his official notice by one of the inspectors for Middlesex.

Lord Colchester stated that a similar letter from the Home Department had been received by the Chairman of Quarter Sessions for Sussex.

After some conversation upon the subject as to any steps that it might be desirable for the Commission to take in the matter, as being connected with the duties of the Inspectors now under consideration, the Chairman proposed the following resolution, which was agreed to:—

> The Warden of the Standards having brought under the notice of the Commission certain communications between the Home Secretary and the Middlesex magistrates upon the subject of the inspection of canteens, the Commission are of opinion that the existing provisions of law for the inspection of weights and measures, which appear to be applicable to weights and measures in canteens, should be maintained.

Mr. Cave proposed to communicate privately with the Home Secretary, with a view of asking a question upon the subject in the House of Commons.

11. The Commission proceeded with the further consideration of the proposed resolutions relating to the inspection of weights and measures, contained in Paper XIV.-I.

In reply to Sir J. G. S. Lefevre, the Warden said that he had drawn up a preamble, as requested at the last meeting, which he had placed in the hands of the Chairman. This preamble was intended to apply generally to the whole of the resolutions. He had not followed the course adopted upon former occasions, of reciting the grounds upon which each separate resolution was based, in consequence of the numerous points of detail embraced in these resolutions, his object being to bring them into as small a compass as possible. The real preamble to these resolutions and the reasons upon which they were provided, were to be found in Paper XIV.-I. It was obvious also that when such great and important changes in the law were proposed by the Commission, it would be incumbent upon them fully to state their reasons in the Report, and also to refer to the evidence laid before them, bearing upon the subject. With this view he had submitted to the Chairman, for his consideration, a draft of a proposed portion of their Fourth Report, as an illustration of its bearing upon the resolutions.

25TH MEETING, 9 April 1870.

The Chairman said that it would doubtless be requisite that a full statement of the reasons, justifying their recommendations, should appear in the Report, and he would gladly leave the preparation of these details to the Warden. At the same time, he thought it very desirable that the Commission should also pursue the method hitherto adopted of briefly reciting the grounds of their several resolutions, and this might be conveniently done by a preamble to each separate head, under which the resolutions were classed.

Mr. Cave and Sir J. G. S. Lefevre entirely concurred in this opinion, and in the propriety of continuing the satisfactory form of resolution adopted in former Reports. Sir J. G. S. Lefevre suggested that as the Commission were already acquainted with the grounds upon which the resolutions relating to the inspection of weights and measures were based, it would be better to proceed at once to their consideration, and after they had agreed upon the resolutions they might settle the preamble to each head.

Some further discussion having taken place, the Commission approved of this suggestion, and it was left to the Warden to prepare and lay before the Commission at their next meeting the requisite preliminary recitals, by selecting from the preamble now prepared the portions applicable to the respective heads.

The Chairman then read the preamble already submitted, containing a statement of the grounds for the principal recommendations, and proceeded to read the proposed resolutions *seriatim*.

After various explanations were given by the Warden, the following resolutions 1 to 21 were passed unanimously, some verbal alterations having been suggested and agreed to:—

§ I.—*Establishment of a more Uniform and Efficient System of Verification and Inspection of Weights and Measures.*

(1.) That it is expedient to establish a more uniform, efficient, and responsible system of local verification and of inspection of weights and measures throughout the United Kingdom.

§ II.—*Local Authorities of Districts of Verification and of Inspection.*

(2.) That the authority over the verification and the inspection of weights and measures in Great Britain be withdrawn from the control of all Corporations of Cities, Town Councils of Municipal Boroughs, Courts of Burgesses, Universities, Lords of Manors and Courts Leet, Ward Inquests, Parish Vestries, and other such corporations and persons in which it is now vested by statute, charter, custom, or local Act, and be transferred to the county magistrates, except in such of the more important and populous cities and boroughs as Parliament may determine; and that in such cities and boroughs to which the authority of the county magistrates over the verification and inspection of weights and measures shall not extend, the authority be placed in the hands of the local magistrates.

(3.) That the authority over the verification and inspection of weights and measures in Ireland remain with the Inspector-General of Constabulary, except in certain parts of the police district of Dublin Metropolis, as defined by the Act 30 & 31 Vict. c. 94, where it shall remain with the Commissioners of Metropolitan Police; and that the several local districts of verification and inspection shall be regulated from time to time by the Inspector-General of Constabulary, with the approval of the Board of Trade.

§ III.—*Separate and distinct System of Verification and of Inspection of Weights and Measures.*

(4.) That the duties of verification and of inspection of weights and measures in the several districts be separated and exercised by distinct local officers.

25TH MEETING, 9 April 1870.

§ IV.—*Districts of Verification and Appointment of Verifiers of Weights and Measures.*

(5.) That the several districts of verification in the United Kingdom be so arranged that one duly qualified Verifier, responsible for the duties of verification, be appointed in each county, or large division of a county, as well as in each of the larger and more populous cities and boroughs in Great Britain, to which the authority of the county magistrates shall not extend.

(6.) That the union, by agreement, of adjacent counties, for the purpose of verification of weights and measures be authorized by law.

(7.) That Sub-Verifiers of weights and measures, subordinate to the Verifier, be appointed in such districts as may require them.

(8.) That the Verifiers give up their whole time to their duties of verification, if required by the local authorities, such adequate remuneration being given to them and to the Sub-Verifiers, by way of salary and not by fees, as the local authorities may determine, with the approval of the Board of Trade; and that the local authorities be empowered to award to them such retired or superannuation allowance as they may think fit.

(9.) That the Verifiers and Sub-Verifiers in Great Britain be appointed by the county magistrates, or by the local magistrates mentioned in Resolution 2, and in Ireland by the Inspector-General of Constabulary or the Commissioners of Dublin Metropolitan Police, the appointments of Verifiers being in every case subject to the approval of the Board of Trade.

(10.) That previously to such approval, and in order to show that any such person is duly qualified to act as Verifier, a certificate be transmitted to the Board of Trade by the local authorities that the Verifier nominated for appointment has passed such special examination before the Civil Service Commission as the Board of Trade shall from time to time determine.

(11.) That such certificate from the Civil Service Commission be not required in first appointments under the new system, provided that the magistrates certify that such person is duly qualified to act as Verifier from his previous experience as Inspector of weights and measures.

(12.) That it be recommended in future appointments of Verifiers that they be selected from the class of Sub-Verifiers, and that in those districts where the inspection of weights and measures is exercised by officers of the police, the duties of verification be generally entrusted to such officers of police, as being more especially qualified for the duties by their experience, habits, and knowledge of the locality; and as an encouragement to their good conduct from looking forward to such appointments by way of promotion.

(13.) That the Verifiers be liable to suspension or dismissal by the local authorities, with the approval of the Board of Trade, for misconduct, neglect, or inefficient performance of their duties, or other sufficient cause.

(14.) That the expenses of verification in each district of verification be paid out of the local funds, boroughs paying their due proportion of sums expended out of the county rate, after deducting corresponding receipts in aid of such county rate, as provided by the Municipal Corporations Act of 1835; such expenses consisting of the salaries of the Verifiers and other expenses attending the verification, including standards and other apparatus, and proper offices for the discharge of the duties; and that all fees of verification be carried in aid of such local funds.

§ V.—*Duties of Verifiers of Weights and Measures.*

(15.) That the duties of Verifiers of weights and measures consist in the custody, preservation, and use of the local standards and other instruments of verification, and the due discharge of the several services connected therewith, including the testing and stamping from time to time of all legal weights and measures, and balances, and other weighing instruments.

(16.) That they be responsible that the local standards in their districts, used for the purposes both of verification and inspection, be maintained in due conformity with the legal standards, and be duly reverified from time to time at the periods described.

(17.) That they perform their duties according to such instructions as shall from time to time be furnished to them under the authority of the Board of Trade.

(18.) That not only all weights and measures, but also new balances and weighing machines, be tested by the Verifier and duly stamped or marked by him, when found correct, before being sold for use or being used for the purposes of weighing or measuring commodities for buying or selling or transport.

(19.) That before stamping any new weight, measure, balance, or weighing machine, the Verifier see that it is properly constructed, according to the regulations of the Board of Trade.

(20.) That it is desirable to provide in such regulations that the beams of all balances be steeled at their centres and bearings.

(21.) That every iron weight have only one leaden plug for adjustment, not larger than sufficient to receive the several stamps.

In discussing Resolution 22, the Warden explained that a sufficient reason for prohibiting earthenware weights was the considerable difference of weight which might be caused by their absorbing water when wetted, thus facilitating frauds upon the public. As, however, a large number of these weights were now used by tradesmen, he thought it would be right that a specified time should elapse before such weights should be prohibited.

Professor Miller was strongly of opinion that these eathernware weights should not be allowed for the reason stated.

The Warden exhibited an earthenware pint measure, with a small piece of tin bent round the handle, and soldered together for receiving the inspector's stamp. This mode of stamping had been adopted by the inspector in Middlesex, and was found practically to answer the purpose required.

Professor Miller suggested that the Austrian mode of stamping earthenware or glass measures would be found convenient and useful. A small round hole was made through the side of the vessel, about half an inch from the brim, and a metal plug inserted to receive the stamp of verification, which was affixed on both sides by means of a pair of pincers. The top of this plug defined the measure, and the measured quantity of liquid was thus easily carried, without spilling any portion of it.

The following resolutions 22 to 64 were then passed unanimously, after having been read and discussed by the Commission, and some verbal alterations made:—

(22.) That all earthenware weights be prohibited, after a period to be specified, and that all glass weights and measures, and earthenware measures, be constructed and stamped or marked as shall be determined upon.

(23.) That all measures of capacity constructed of wood be of a cylindrical form, with a plain and even bottom, and not turned out of solid wood.

(24.) That before testing or stamping any weight or measure, the Verifier see that it bears its legal denomination legibly marked upon it.

(25.) That all new weights, measures, balances, and weighing machines, bear the stamp of the maker.

(26.) And that all lever weighing machines with special weights be constructed and adjusted so that the weights shall be of legal denominations; and that all such lever weighing machines now in use, having weights other than of legal denominations, be, after a specified period, altered and readjusted, with weights of legal denomination, and, together with the weights, be duly verified and stamped.

(27.) That Verifiers stamp all new weights, measures, and balances with a verification stamp containing the number or distinctive mark of the district, and with a stamp denoting the year.

(28.) That such stamps of verification be provided, at the cost of the Government by the Board of Trade, and furnished to the Chief Verifier of each district by the Warden of the Standards.

(29.) That the stamps remain the property of the Government, reclaimable by the Board of Trade, through their officer the Warden of the Standards, at any time if occasion should so require it, in order to prevent an improper use being made of such verification stamps.

(30.) On reverifying weights and measures in subsequent years, only the one or the two last ciphers of the date year in the same century be restamped.

(31.) That Verifiers charge such fees as shall be duly authorized from time to time by the Board of Trade for the comparison and stamping, or for the adjustment of weights, measures, &c., and that they duly account for the amount to the local authorities.

(32.) That no weight or measure of any other denomination than the official Standards be stamped by the Verifier, or be a legal weight or measure.

(33.) That all weights and measures, after readjustment, be compared and restamped by the Verifier, who shall charge the authorized fee.

(34.) That the Verifier do not restamp, during the same year, weights and measures previously stamped and which

25TH MEETING, 9 April 1870.

he shall find upon comparison to be correct, but that he be empowered to charge the verification fee.

(35.) That every Verifier keep a book in which he shall enter minutes of all weights and measures, compared, and stamped, or adjusted, with the amount of fees received by him.

(36.) That all weights, measures, balances, or weighing machines used for trade purposes be reverified at least once in every year, and that the periodical reverification of such weights, measures, balances, and weighing machines be conducted by the Verifiers as they shall be required by the official instructions of the Board of Trade.

(37.) That no weight or measure which may be found defective or incorrect be mended or adjusted by a Verifier (unless it be a small rectification, for which no charge is made) except upon the special authority of the Board of Trade granted to such Verifier, who shall be empowered to charge a specified sum for mending and adjusting according to a scale to be approved by the Board of Trade.

(38.) That such authority may be granted upon application under the hands of two magistrates of the district, who shall certify that such permission for the Verifier to adjust is needed to meet the requirements of the neighbourhood, and that the Verifier is himself competent to adjust, or has a competent mechanic or mechanics to work under him with all the necessary appliances.

(39.) That in case any weight or measure be found by the Verifier to be defective or incorrect, and be returned for readjustment, he shall always give a brief certificate of the error of the weight or measure so rejected.

(40.) That no Verifier be a maker of weights, measures, or balances.

(41.) That every Verifier make such returns to the Warden of the Standards, in relation to the instruments and duties of verification in his district, and in such specified form, as the Board of Trade shall from time to time require.

(42.) That he give such aid or assistance to Inspectors of weights and measures in the discharge of their duties, as shall be required by the official instructions of the Board of Trade.

§ VI.—*Standards and other Instruments of Verification.*

(43.) That one complete set of all the local standards required for his district of verification, duly verified at the Standards Department, be kept by the Verifier as standards for reference, and that the weights belonging to such set be reverified at the Standards Department not less than once in every five years, and measures not less than once in every ten years, and oftener, if required.

(44.) That all other standards required in his district for comparing and verifying commercial weights and measures, both for the use of the Verifiers, and of the Inspectors, (excepting supplementary iron 56 lbs. weights for testing weighbridges or weighing machines for heavy goods, waggons, &c.,) be originally verified and officially stamped in the Standards Department, and may be locally compared and reverified by the Verifier, in presence of a witness, with his standards for reference, within the like periods.

(45.) That for the purpose of testing large weighing machines and weighbridges, it be lawful for Verifiers and Inspectors to use such number of supplementary iron 56 lbs. weights as may be requisite, together with at least one local standard weight of 56 lbs. duly verified; and that every such iron 56 lbs. weight be cast with the number of the district in which it is used marked upon it, and be compared once a year by the inspector with a local standard weight duly verified, in the presence of a witness.

(46.) That a report of every such local reverification, attested by the signature of the witness, be transmitted by the Verifier to the Warden of the Standards, who shall, if he approve such reverification, transmit his certificate accordingly, and the Verifier or other officer shall not use such Standards and supplementary iron weights for comparing weights and measures or weighing machine until such certificate shall have been received by him.

(47.) That where there are several sets of local standards in any county or district of verification or of inspection, which may be required to be reverified from time to time at the Standards Department, it be the duty of the Verifier and of the Inspector to take care that they are sent at different periods, so that there be as little suspension as possible of the duties of verification and inspection, and that a spare set of Standards be kept to supply the place of any set sent to London for readjustment and reverification.

(48.) That the provisions of the Weights and Measures (Ireland) Acts of 1860, 1862, and 1867 for legalizing sub-standards of iron for the use of Inspectors of weights and measures be repealed.

(49.) That the form, material, &c. of all local Standards, together with the balances, stamps, and other apparatus used by the Verifiers, be subject to such regulations as shall from time to time be issued by the Board of Trade.

(50.) That every Verifier have his Standards, balances, and other apparatus, ready for inspection at such place and time as may be fixed from time to time by any official Inspector of Standards duly appointed.

(51.) That no local Standard which may have become defective and shall have been mended or readjusted, be legal, until reverified and restamped in the Standards Department.

(52.) That no local Standard which may have become defective be adjusted by any Verifier, or Inspector of weights and measures.

(53.) That mural or public Standards of length be securely fixed for public use in all populous towns, and the expenses connected with them be defrayed from the local funds. The local authorities to be responsible for keeping them in good order, and the local Inspectors to report to them periodically on their condition. These public Standards not to be valid for convictions of false or defective measures.

§ VII.—*Inspectors of Weights and Measures.*

(54.) That in all districts of verification of weights and measures, special officers of the police or other competent persons be appointed Inspectors of weights and measures by the before-stated local authorities, and charged with the duties of inspecting weights, measures and balances, and the detection and prosecution of offences against the weights and measures laws.

(55.) That every such appointment be subject to the approval of the Board of Trade.

(56.) That the Inspectors be liable to suspension or dismissal by the local authorities, with the approval of the Board of Trade, for misconduct, neglect, or inefficient discharge of their duties, or other sufficient cause.

(57.) That such Inspectors be furnished by the local authorities with local Standards of weights and measures, duly verified and reverified from time to time, for the comparison of weights and measures.

(58.) That such of the existing Inspectors of weights and measures as the local authorities of the several districts shall think fit, subject to the approval of the Board of Trade, continue to exercise their duties either of inspection or of verification, and be paid such remuneration, by way of salary and not by fees, or a proportion of fines, but including compensation for loss of fees, or of their proportion of fines, as shall be awarded to them by the local authorities, with the approval of the Board of Trade.

(59.) That the local authorities in such districts be empowered to grant such retired or superannuation allowances to Inspectors of weights and measures as they shall think fit.

(60.) That in all districts of inspection where the duties are exercised by the police, the chief officer of police in each district be more immediately charged with and responsible for the duties of inspection of weights and measures, and the custody and care of the instruments of inspection; the actual duties of inspection being performed in the several sub-districts by officers of police subordinate to the chief officer, and acting under his directions, and specially selected for this purpose, such officers being as much as possible relieved from ordinary police duties.

(61.) That the chief officer of police in each such district, or the Inspector charged with these duties, make such returns to the Warden of the Standards, in relation to the inspection of weights and measures, and convictions, within his district, in such specified form as shall from time to time be required by the Board of Trade.

(62.) That the local authorities in each district be empowered to award such remuneration to the chief or other officer of police, or other inspector, for the discharge of the duties of inspection of weights and measures, as they shall think fit, with the approval of the Board of Trade; but that it be lawful for the Board of Trade to revoke this approval in case of any neglect of duty in relation to the inspection of weights and measures by such officer.

(63.) That every Inspector of weights and measures be empowered, without any further warrant from any justice than his instrument of appointment, at all reasonable times to enter all shops and other places within his district, where goods are exposed for sale or weighed for transport, and

25TH MEETING, 9 April 1870.

not only to seize and render liable to forfeiture all beams, scales, balances, and other weighing machines not exceeding 5*l.* in value, which appear to be fraudulently unjust, as well as false, defective, or unjust weights and measures, but also if they find that any fraud shall be wilfully committed in the using thereof; and that the several provisions for prevention of fraud contained in sections 14, 15, and 16 of the Irish Weights and Measures Act of 1862, be extended to Great Britain.

(64.) That any person who shall without due authority represent himself to be an Inspector of weights and measures, and shall act as such Inspector, be liable on conviction to a fine not exceeding 5*l.*, or to imprisonment not exceeding two months, as the magistrates shall determine.

(*The Astronomer Royal left, and Lord Colchester took the Chair at his request.*)

On reading Resolution 65 for empowering county magistrates to adjudicate in boroughs on weights and measures cases, a question was raised whether such a provision was needed, and whether the requisite power did not already exist; and the consideration of the resolution was postponed, the Warden being requested to obtain the necessary information.

A similar course was pursued with respect to the proposed Resolution 66 for empowering county Inspectors to act in boroughs.

The following Resolutions 67 to 74 were read and agreed to:—

(67.) That in all informations laid for offences against the weights and measures laws, it be distinctly stated whether the offence be committed "with fraudulent intent," or "with no intent to defraud," and that persons convicted of offences with fraudulent intent, in respect of weights, measures, or balances, or their use, or dealings in connexion therewith, be subject to a greater fine than offenders with no intent to defraud; and that in cases of a second conviction with fraudulent intent, the offender be liable to a heavier fine, or to imprisonment not exceeding two months, as the justices may determine.

(68.) That in all cases of conviction with fraudulent intent, or of culpable negligence, the magistrates shall take the necessary steps for publishing the name, place of abode, and business, offence, and sentence of each person convicted, in one or more of the local newspapers.

(69.) That the duties of inspection which consist of the testing the legality of weights, measures, and balances, be subject to such regulations as shall from time to time be issued by the Board of Trade.

(70.) That no commercial weight, measure, or balance, which may have become defective or incorrect, be mended or adjusted by any Inspector of weights and measures.

(71.) That in cases in which weights, measures, or balances may be found accidentally or trivially defective, without imputation of fraud or culpable negligence, the magistrates be authorized, if they think fit, to dismiss the case without inflicting a penalty.

(72.) That in all cases where stated quantities of any articles of food are made up in bags or parcels ready for sale in shops or public places, they shall have the weight or measure legibly marked upon them, and Inspectors be empowered to require any three of each description of such bags or parcels to be produced before him, and to weigh or measure the same, and if found unjust, to seize them, and inform against the offenders, who, on conviction, shall be liable to a penalty.

(73.) That all fines and penalties in connexion with weights and measures, be carried to the local funds applicable to the expenses of inspection.

(74.) That all expenses of inspection of weights and measures in the several districts of inspection be paid out of the local funds.

§ VIII.—*Other duties connected with or analogous to the Inspection of Weights and Measures.*

(75.) That the several provisions relating to the weights and scales used by bakers, and to the weighing of bread, and to the adulteration of bread, &c., contained in the Bread Acts now in force in the United Kingdom, be repealed; and that the several enactments relating to the weights and scales used by bakers, and to the weighing of bread (with the exception of the provision requiring weights and scales to be carrred by bakers when delivering bread), be embodied in the proposed Weights and Measures Consolidation Act, and the duties of verification of such weights and scales, and their inspection, including that of the bread sold, be exercised by the Verifiers and Inspectors of weights and measures.

On the passing of Resolution 75, relating to the weighing and adulteration of bread, the Warden reported the proceedings taken by one of the Inspectors of Middlesex for detecting and obtaining convictions for the adulteration of bread, which had been brought under his notice, and exhibited to the Commission printed forms of the summonses, informations, and convictions.

The following Resolutions 76 to 84 were also read and agreed to:—

(76.) That the several provisions relating to the adulteration of bread, &c. be embodied in a separate Bill relating generally to the adulteration of food or other articles, when it may be considered how far it is expedient to impose the duties of carrying out the Act in the different localities upon the Verifiers or Inspectors of weights and measures.

(77.) That the existing provisions of law, by which powers analogous to those of Inspectors of weights and measures are conferred upon clerks of markets and hay weighers, be similarly dealt with.

(78.) That the same principle be carried out with regard to the existing provisions of law for the sale and delivery of coal, which should be made applicable to the whole of the United Kingdom.

(79.) That the existing provisions of law imposing upon the Inspectors of weights and measures the duties of testing petroleum, require amendment, with a view to establishing a uniform testing apparatus and mode of testing petroleum.

§ IX.—*Verification and Inspection of Post Office, Customs, and Excise Weights and Measures, &c.*

(80.) That all weights and measures used by the Revenue Departments of Customs, Excise, and Post Office for regulating charges upon the public be of legal denominations, according to the official Standards of the Board of Trade, and be duly verified and stamped from time to time, either by the local Verifiers of weights and measures, or by departmental officers appointed by the authorities of the several departments for the discharge of this duty.

(81.) That for such purposes the departmental officer of verification be furnished by the authorities of the Customs, Excise, and Post Office Departments with such copies of the Standards as they may require, to be duly verified from time to time by the Standards Department of the Board of Trade, within the periods prescribed by law for the reverification of copies of the Standards provided for the local Verifiers of weights and measures.

(82.) That upon the appointment of such officers of verification being notified to the Board of Trade by the departmental authorities, such officers be furnished by the Warden of the Standards with the requisite verification stamps, and with copies of the official instructions of the Board of Trade to Verifiers and Inspectors of weights and measures, with the view of aiding them in the performance of their duties.

(83.) That the periodical inspection and reverification of all weights, measures, and balances used by officers of the Customs, Excise, and Post Office Departments for regulating charges made upon the public, be carried out by the departmental officer of Inspection and Verification appointed to discharge those duties, under the authority and responsibility of the heads of those departments. As respects the Post Office Department, that this provision apply only to the scales and weights specially constructed for Post Office services only, and supplied by the Postmaster General. And that all other scales and weights used for Post Office purposes, and also for trading purposes by post office keepers, be subject to verification and inspection from time to time by the local Verifiers and Inspectors of weights and measures, under the provisions of the general law.

(84.) That with a view of checking from time to time the accuracy of the before-mentioned special scales and weights used in post offices, they may be tested by the local inspectors of weights and measures, but not for the purpose of applying any penal consequences to postal officers. Any defects found in such scales and weights should be reported to the General Post Office, in order that they may be rectified.

On arriving at § X., relating to the proposed amendments in the Sale of Gas Acts, the Warden said that the subject had not yet been brought so fully under the cognizance and consideration of the Commission as the inspection of weights and measures, and the proposed resolutions would probably require some deliberation and discussion.

25TH MEETING, 9 April 1870.

It was consequently agreed to postpone the consideration of the remaining resolutions until the next meeting.

The Commission fixed Saturday, 30th April, at 11 a.m., for the next meeting.

Adjourned at 3.30 p.m.

COLCHESTER.

26TH MEETING, 30 April 1870.

TWENTY-SIXTH MEETING.—SATURDAY, 30th APRIL 1870, at 11 a.m.

PRESENT :

The Lord Colchester (in the Chair).
The Right Honourable Stephen Cave, M.P.
Sir J. G. Shaw Lefevre, K.C.B.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. A letter from the Astronomer Royal was read, stating that indisposition prevented his attendance, and transmitting some corrections in the Minutes of the last meeting; requesting also Lord Colchester to take the Chair.

2. The printed Minutes of the 25th meeting were corrected and confirmed.

3. The Warden laid before the Commission the following printed Papers :—

Corrected pages 59–74] of Paper XIV.-I., containing preambles to the proposed Resolutions.

P.S. to Paper XXI., on the Standard weights and measures of the United States of North America.

Further official documents received from Washington through the United States Legation.

Copy, in German, of official Regulations and Instructions relating to Metric weights and measures in the North German Confederation received from Berlin.

Appendices to the Fourth Report of the Commission, corrected to p. 316.

Gold Standarding Tables, received from the Bank of England.

Observations on Gas Meter Testing, by Mr. F. W. Hartley.

The Warden reported the further progress made in printing the Appendix to the Fourth Report. The translation of the German official Instructions, relating to Metric weights and measures, was being proceeded with as rapidly as possible, to form part of the Appendix.

He observed also that much useful information upon the subject of the testing of gas meters would be found in Mr. Hartley's book; and that a new photometer had been designed and constructed by Mr. Hartley, which he would be glad to exhibit to the Commission, at Messrs. Wright's works at Millbank Street. The peculiarity of its construction was that three separate observers could test the illuminating quality of any given volume of gas at the same time and under precisely similar circumstances.

4. The Warden exhibited to the Commission,—

Regnault's condenser hygrometer obtained from Deleuil, at Paris.

A 3 litre flask for weighing gases or liquids, also from Deleuil.

A newly constructed apparatus for testing petroleum, made by Mr. W. Sugg.

A King's pressure gauge, showing the pressure of gases in hundreds of an inch, furnished by Messrs. Wright.

Specimens of gun-metal with mixture of iron, from Messrs. Troughton and Simms.

He also reported that the new kilogram balance, ordered from Mr. Oertling, had been delivered on the 28th instant, and was now ready for Departmental use.

5. The Warden said that he had received no further information as to the nomination of Commissioners to the International Standards Commission at Paris, and, in reply to a question from the Chairman, explained that the duties of the International Commission would consist in the construction and verification of a new primary Standard metre and kilogram, and a sufficient number of copies of a primary character for the several countries represented in the Commission. The duties would necessarily involve many points of detail, as to the material of the Standards, improvements, and mode of verification, &c., to which the latest discoveries of modern science would be made applicable. He considered that the work could not be completed in less than two years.

Professor Miller concurred in this opinion.

6. The Commission proceeded with the consideration of the proposed Resolutions and preambles contained in the corrected pages of Paper XIV.-I., in continuation of their proceedings at the last meeting.

26TH MEETING, 30 April 1870.

The following preambles to § § I.—VII. were read, and after some discussion and amendments were agreed to as follows :—

§ I. *Establishment of a more uniform and efficient system of Verification and of Inspection of Weights and Measures.*

Considering,—

That the Act of 1824 for establishing uniformity of weights and measures contained no provisions for uniformity of inspection of these weights and measures;

That the Act of 1835, under which local inspectors were appointed, for discharging the duties both of verification and inspection of weights and measures, expressly sanctioned the continuance of existing powers and privileges of verification and inspection in the several localities;

That further powers for these purposes have since been granted by Parliament in public and local Acts;

That the want of uniformity in the several modes of verification and inspection constitutes a serious defect in the system now in force;

That as regards Great Britain, no control or supervision by any responsible public department over the appointment of Inspectors and the performance of their duties now exists, nor are adequate means provided for securing the due and uniform discharge of their duties;

That numerous complaints have been made in petitions presented to Parliament in recent sessions, and in documents laid before us, of the unsatisfactory state of the existing laws relating to the inspection of weights and measures, and praying for their amendment;

That full evidence of many defects in the existing law and practice has been submitted to us by competent witnesses, and is contained in the papers officially laid before us;

That in order to carry out advantageously the recommendations contained in our Second and Third Reports, relating to important alterations in the weights and measures now legalized for use, and more particularly the permissive introduction of metric weights and measures, it appears to us requisite that an improved system of verification and inspection be adopted, both in Great Britain and in Ireland;

We are of opinion—(*See Resolution* (1) *passed at the last meeting.*)

§ II. *Local Authorities of Districts of Verification and of Inspection.*

Considering,—

That with respect to the local authorities under whom the inspection of weights and measures is now placed, it appears to us to be wrong in principle and injurious in practice, that such authority should be exercised in towns and boroughs by Corporations and Town Councils, members of which frequently are tradesmen using weights and measures subject by law to inspection;

That we are satisfied from the information laid before us that in many of such towns and boroughs the inspection is very inefficiently carried out, and the provisions of law relating to weights and measures very inadequately complied with;

That it appears from evidence laid before us that the inspection of weights and measures in many of such towns and boroughs of Great Britain has been voluntarily transferred to the county inspectors;

That the authority now exercised by lords of manors, courts leet, parish vestries, companies, and even private persons, whether by statute, charter, or prescription, is unsuited to the circumstances of the present time, and materially interferes with the establishment of a uniform and efficient system of inspection;

That it has been shown to us that it is expedient to amend the provisions of the Weights and Measures (Ireland) Act of 1862, requiring each petty sessional district of a county, and each borough in Ireland, to be made a separate district of inspection of weights and measures;

We recommend—(*See Resolutions* (2), (3), *passed at the last meeting.*)

§ III. *Separate and distinct system of Verification and of Inspection of Weights and Measures.*

Considering,—

That a manifest distinction exists between the duties of verification and those of inspection of weights and measures;

That the Verifier has to test weights and measures, and ought, in our opinion, also to test balances, for the purpose of ascertaining that these instruments are properly constructed and duly accurate, and of certifying to their correctness by a stamp, thus acting for the protection both of the tradesman and his customers, whilst the Inspector has only to satisfy himself that these instruments are not grossly defective or fraudulent, to the detriment of the public, in which case he is to take legal proceedings against the offender;

That the duties of a Verifier are performed chiefly in his office or workroom, being thus of an official or mechanical character, whilst those of an Inspector consist in visiting shops and other places of trade, and are of the nature of police duties;

That the discharge of the duties of a Verifier requires special qualifications, and far more technical knowledge and skill than those of an Inspector;

That previously to the passing of the Act of 1834, the duties of verification and stamping and those of inspection were always exercised by separate and distinct officers, and that even now these duties are so performed in many localities, particularly in the City of London, where, according to evidence received by us, they are very satisfactorily discharged;

That in France, Germany, and other countries, where much attention has been given by the authorities to the subject of weights and measures, special officers are appointed as Verifiers, whilst the duties of inspection are left to the police;

That under an improved system of verification in this country, and upon the legalization of metric weights and measures, the duties of verification must necessarily be largely increased, and in order that these duties may be properly discharged, we are satisfied that it will be requisite to adopt means for securing the appointment of duly qualified Verifiers in the several localities;

We recommend—(*See Resolution* (4) *passed at the last meeting.*)

§ IV.—*District of Verification, and appointment of Verifiers of Weights and Measures.*

Considering—

That it has been proved to us that the duties of verification of weights and measures are now exercised by not less than 1,355 separate officers, in as many districts of inspection in the United Kingdom, viz., 731 in Great Britain, and 624 in Ireland;

That out of the total number of Inspectors of weights and measures in the United Kingdom, at the present time, about 1,100, or more than 80 per cent., are police officers, who have their police duties to attend to, and who, as a general rule, have no remuneration for their services in relation to weights and measures;

That in Ireland, the duties of verification are performed in the 624 districts of inspection by as many separate officers of the Constabulary force, who are *ex officio* Inspectors of weights and measures, discharging these duties, under s. 5 of the Act of 1862, without fee or reward;

That the law now provides no security for the appointment of persons duly qualified to discharge the duties of verifying weights and measures, and makes no provision for their adequate remuneration;

That we are satisfied that such duties of verification are in general very imperfectly and inadequately discharged;

We recommend—(*See Resolutions* (5) *to* (14) *passed at the last meeting.*)

§ V.—*Duties of Verifiers of Weights and Measures.*

Considering—

That it has been proved to us that no uniform system of verification is now practised, instances frequently occurring of weights and measures being verified and stamped as legal in one district of inspection, whilst such are rejected as illegal in an adjoining district;

That evidence produced before us has satisfied us that the law should provide against the sale and use of fraudulent and defective balances, by requiring them to be tested and stamped before being sold for use;

That it is expedient for the protection of the public, and for establishing a uniform and efficient system of verification, that authoritative regulations should be laid down by a responsible public department for the construction and verification of all such balances and of weighing machines;

That for the same reasons, and in order to carry out the recommendation in our Second Report for adopting conspicuous distinctive forms or marks for the several weights and measures of the imperial and of the metric system, it is expedient that similar regulations should be issued for the construction and verification of all such weights and measures;

That similar regulations will be requisite for establishing a more uniform and efficient system of periodical reverification of weights, measures, and balances, and their stamping;

That in order to distinguish more readily between weights and measures of the Imperial and of the Metric system, and between measures of capacity and vessels for containing liquids and other articles, it is expedient that all legal weights and measures should have their legal denominations legibly marked upon them;

That it has been shown to us that it is now the practice in many districts of inspection for the Inspector to adjust weights and measures before verification, and to charge a fee for such adjustment, and that frequently the work is very imperfectly done;

We recommend—(*See Resolutions* (15) *to* (42) *passed at the last meeting.*)

§ VI.—*Standards and other Instruments of Verification.*

Considering—

That there is now no security for requisite care being taken of the local standards and other instruments of verification, entrusted to the custody of the local officers, nor for the requirements of law for their periodical reverification and due accuracy being properly complied with;

That evidence has been produced before us of various irregularities in the local reverification of the standards used by Inspectors;

That it has been shown to us in the First Report of the Warden of the Standards, for 1866–7, that so far as could be ascertained, out of 301 cities and towns in Great Britain, which had been furnished with legal standards since the passing of the Act of 1824, such standard in 120 cities and towns, or 36 per cent. of the whole number, had not been duly reverified, and were consequently not legal standards; that out of 57 manors or liberties, the standards in 44, or 77 per cent., had not been duly reverified; and that the proportion of standards in Ireland which had not been duly reverified was nearly the same;

That no sufficient provision has been made by law, nor adequate means afforded to the local officers, for the verification of large weighing machines and weighbridges;

That we are satisfied that the provisions of existing law authorizing the use, by Inspectors of weights and measures in Ireland, of sub-standards of iron for the verification of commercial weights and measures should be discontinued, and that iron is an unfit metal for such purposes;

That it is expedient that the recommendations contained in Reports of former Standards Commissions, and in our Second Report, for establishing mural or public standards of length, in populous towns, should be more generally carried into effect, such standards as have already been erected having been much used and found serviceable by the public;

We recommend—(*See Resolutions* (43) *to* (53) *passed at the last meeting.*)

§ VII.—*Inspectors of Weights and Measures.*

Considering—

That in regard to the duties of inspection, as distinct from those of verification, it appears to us to be a serious defect in the existing law and practice, that in several districts of inspection in the United Kingdom, wholly different classes of persons exercise the

26TH MEETING, 30 April 1870.

26TH MEETING, 30 April 1870.

duties of Inspectors, there being also a great diversity in the mode in which these duties are discharged, as well as in the mode and amount of remuneration of the Inspectors;

That such duties of inspection are of the character of police duties, being exercised for the detection and punishment of offences against the laws;

That we find the practice has become very general in the counties of Great Britain, to employ the county police in these duties, and the plan is stated by the police authorities to work well;

That out of the 52 counties in England and Wales, the county police are exclusively thus employed in 42 counties, 4 out of the remaining 10 counties being wholly or partly in the Metropolitan district, where the county police are not under the authority of the magistrates; of 34 counties in Scotland, the police are thus employed in 23 counties; and that out of 463 county inspectors of weights and measures in Great Britain, 396, or 85 per cent., are police officers;

That in Ireland the constabulary officers are exclusively employed in these duties of inspection, for which by law they receive no remuneration;

That as a rule officers of police who are employed as Inspectors of weights and measures in Great Britain get no additional remuneration for the discharge of these duties, their actual expenses only being repaid to them;

That it has been shown to us that, so far as could be ascertained from the returns for 1866, whilst the average population of each police inspector's district was 27,507, and other districts, 41,163, the average number of convictions in the year in each district were 5 and 19 respectively;

That whilst, on the one hand, in many large and populous districts where the Inspectors were not remunerated for their duties of inspection, either by salary or from a portion of the fines, no conviction whatever occurred from year to year; on the other hand, a great number of convictions occurred in the metropolitan districts, where the informer gets half the penalties, and a large proportion of the convictions were for small deviations in a single weight or measure out of the whole set, with no intention to defraud;

That evidence has been laid before us to show that the practice of giving a portion of the fines to Inspectors is most objectionable to tradesmen who are subject to inspection, and that they are loud in their complaints of the grievous oppression which they allege is caused by this practice, and of their being consequently summoned for trivial deviations in their weights and measures;

That although there may be some advantage in granting a portion of the fines on convictions to the Inspectors, as stimulating them in the discharge of their duties, yet this practice is adopted only in few districts of inspection, and many objections exist against it;

That with the view to a uniform, efficient, and satisfactory discharge of the duties of inspection, it appears to us to be indispensable that the duties should be performed under a code of authoritative instructions, to be issued from time to time by a responsible public department;

That we think it also requisite that the control of such department should extend to a cognizance and approval of the appointment and remuneration, as well as the dismissal, of every Inspector, and that detailed returns of the inspection exercised and of convictions obtained should be made to the department;

That it appears to us that there are material imperfections in the existing law, inasmuch as no power is given to an Inspector in Great Britain to seize (except in the public streets) even an evidently fraudulent balance, nor to interfere in any way when fraud is practised in dealings with weights, measures, and balances, provided these instruments themselves are correct; and that no difference is made in the provisions for penalties on convictions in the case of fraudulent or merely defective weights, measures, and balances;

We recommend—(*See Resolutions* (54) *to* (64) *passed at the last meeting*).

With respect to Resolutions (65) and (66), the Warden stated that he had been in communication with the Home Department, and it appeared that according to the existing law, as contained in the Act 1 & 2 Geo. IV. c. 63, and 5 & 6 Will. IV. c. 76. s. 111, neither county magistrates nor any officer acting under their authority were empowered to act or intermeddle in any matter or thing arising in any city or borough having a separate Commission of the Peace. He laid before the Commission a printed list furnished to him by the Home Office, showing a considerable number of cities and boroughs in Great Britain for which such exclusive jurisdiction had been granted.

The following resolutions were then read and agreed to:—

> (65.) That the County magistrates in Great Britain be empowered to adjudicate upon cases of offences against the weights and measures laws, arising from time to time in boroughs where the inspection of weights and measures is placed under their authority.
>
> (66.) That any county Inspector duly appointed be empowered to exercise his duties of inspection in any city or borough within the county, provided no Inspector be authorized to be appointed for such city or borough.

The preambles to §§ VIII. and IX. were read and agreed to as follows:—

§ VIII.—*Other duties connected with or analogous to the Inspection of Weights and Measures.*

Considering—

> That the proposed appointment of separate and distinct officers for performing the duties of verification and inspection will render it necessary to make provision by law for the discharge of other and analogous duties now exercised by the Inspectors;

We recommend—(*See Resolutions* (75) *to* (79) *passed at the last meeting*).

§ IX.—*Verification and Inspection of Weights and Measures, &c. in Post Office, Customs, and Excise Departments, and at Canteens in Barracks.*

> Considering that it is expedient to set at rest any doubts which may now exist as to the powers of Verification and Inspection of weights and measures, and other instruments for weighing and measuring, which are used in any public department, or under its authority.

We recommend—(*See Resolutions* (80) *to* (84) *passed at the last meeting*).

On the Commission entering upon the consideration of resolution (85) relating to the inspection of weights and measures in canteens, Mr. Cave stated that the answer given on the 28th instant by the Home Secretary in answer to his question in the House of Commons was not satisfactory, and he proposed to put a further question to the Secretary for War upon the subject.

Lord Colchester stated he should also ask in the House of Lords for an explanation upon this subject, as it would appear to involve an important constitutional question as to the exercise of the power of the Secretary for War to interfere with the civil administration of the Statute Law, without the express authority of an Act of Parliament.

The following resolution was then read and agreed to:—

> (85.) That the local Inspectors be specially authorized by law to inspect weights and measures, &c., at canteens in barracks, and to seize all such as may be defective and fraudulent, and take proceedings against the offenders; but that this power be subject to the general instructions of the Board of Trade, and to such particular instructions as may be issued, in concert with the War Department.

The Commission proceeded to consider the proposed amendments in the Sale of Gas Act, contained in § X.

The Warden said that it was important to consider how far the objections which had been raised against the general adoption of the Act in counties still remained in force. The effect of these objections had been to allow county magistrates the option of adopting it, and, in fact, it had not been adopted in more than one county, Gloucestershire, and only nominally there.

The Chairman having read Earl Cathcart's letter of 24th February 1860, in which the objections were stated, a lengthened discussion was entered into upon the subject; and also upon the question of the authority over the inspection of gas meters in cities and boroughs, as to which the Commission generally concurred that the grounds of objection which existed against the authority over the inspection of weights and measures being held by the

26th Meeting, 30 April 1870.

magistrates of small boroughs, did not hold good in the case of the inspection of gas meters.

The Warden explained that it was obviously desirable to establish a general and uniform system of inspection of gas meters throughout the kingdom, such as was now established in the metropolitan district. The use of gas was being extended year by year, as was shown by the numerous local gas bills brought into Parliament. He could not consider it to be either just or expedient that a general law enacted for the protection of the public at large should be set aside in nearly every district throughout the kingdom merely because the county magistrates did not volunteer to adopt it. For more completely carrying out such a general system, which involved practically only the verification of gas meters, for their inspection as distinct from their verification would probably, as now, be left to the inspecting officers of the gas companies, duly qualified Verifiers would be required such as was proposed by the Commission to be appointed in each county for performing the duties of verifying weights and measures. Such officers could also discharge the duties of verifying gas meters with little additional expense to the county, and under the existing provisions of law; boroughs would be required to contribute their due proportion of the expense incurred.

Mr. Cave said the real objection on the part of the counties was that the boroughs would derive all the benefit, whilst they would contribute only a rateable quota towards the expense.

Sir J. S. Lefevre asked what would be the use of compelling a county to adopt the Act, supposing that the consumption of gas was confined to boroughs within the county in which there was a separate inspection of gas meters.

The Warden replied that there must be continually instances of districts outside the limits of boroughs which were supplied with gas from such boroughs. In all such cases, so far as relates to Ireland, the provisions of the Act of 1859, now in force, extend the borough jurisdiction to all meters supplied with gas manufactured within the borough; but not so in Great Britain, where the existing law entrusts to the county magistrates the authority over the inspection of gas meters in all boroughs which did not adopt the Act within six months of its passing. The general principle now established by law was therefore, that in the inspection of gas meters the authority should be vested in the county magistrates, both in county and borough districts; but at present, there was this dilemma, that the boroughs could not, and the counties would not, adopt the Act. In boroughs also in which the Act had been adopted within the period prescribed by law, the authority was vested in the borough magistrates in all cases where the Town Council were manufacturers of gas; and even in a borough, where the Town Council do not themselves make the gas, the Commission have the evidence of Mr. Crosley, that undue influence over the inspection of gas meters has been used in the Town Council by a gas meter manufacturer. Upon all these grounds, he was entirely of opinion that an alteration of the law was imperatively called for with the object of a more general adoption of the Act by counties, and of vesting the authority in all boroughs where a separate inspection of gas meters should be allowed by law, in the borough magistrates only.

The Chairman suggested that the difficulty as to counties might be met by requiring the Act to be adopted in all counties, except where a majority of the magistrates in Quarter Sessions should, within a period to be specified, pass a resolution that sufficient grounds existed for not adopting the Act in such county. The Commission approved of this suggestion.

Professor Miller said he thought the present mode of constructing gas-measuring standards for testing meters was not so simple, and the apparatus was more expensive than it might be. He thought that a modification of the aspirator ordinarily used, and such as is shown in Regnault's apparatus now exhibited, might be employed.

The Warden replied that the standard cubic foot and its apparatus, which was used for the reverification of the gas-measuring standards, was upon this principle, and it was worth considering whether it might not be more generally used. It might also be desirable that test-meters might be authorized to be used, as recommended in Mr. Hartley's pamphlet, and he had included a resolution for effecting this object.

The following resolutions were then read by the Chairman, and were unanimously agreed to:—

26th Meeting, 30 April 1870.

§ X.—*Proposed Amendments in the Sale of Gas Acts.*

Considering—

That important amendments in the Sale of Gas Act, 1859, were fully considered and agreed upon by a Select Committee of the House of Commons in 1860, but have not since been embodied in an Amending Act; and that we are satisfied from information which has been laid before us, that it is expedient such amendments should generally be carried into effect;

That a short Amending Act was passed in 1860, containing a provision for allowing magistrates in counties the option of adopting the Act of 1859, the effect of which has been to make the Act of 1859 a dead letter throughout a great part of the United Kingdom, so far as regards the inspection of gas meters;

That the grounds of such provision appear in a letter from Earl Cathcart, dated 24th February 1860, which was laid before the House of Commons; but that it appears to us that there is now little force in the objections thus raised, which were based upon the apprehended large expenditure to be defrayed from county rates, and that such objections should no longer stand in the way of the application of a general law, and prevent the establishment of a uniform and efficient system of inspection of gas meters throughout the Kingdom;

That with the view of establishing such a system, it is obviously expedient to adopt the several regulations relating to the verification and inspection of weights and measures, so far as they may be properly applicable to gas meters;

That under the provisions of the Act of 1859, accurately verified copies of the gas-measuring standards, of a primary character and of similar construction to the official standards, have been supplied at the public expense to the Corporations of London, Edinburgh, and Dublin; and that it is expedient that provision should be made by which the standards thus supplied to the metropolitan cities of Scotland and Ireland may be more serviceable to the public;

We recommend—

(86.) That the Sale of Gas Act, 1859, and subsequent Acts relating to it, be repealed, and their provisions be re-enacted in the proposed Act for amending and consolidating the laws relating to weights and measures, with the following modifications:—

(87.) That such provisions be adopted in every county throughout the United Kingdom, where gas is manufactured and sold, under the authority of Parliament, except in such counties in England and Wales, in which the magistrates in Quarter Sessions, or in Scotland the Commissioners of Supply, or in Ireland the Grand Jury, shall determine, by a resolution to be passed within a specified period, by a majority of not less than two-thirds of those present, that there are not sufficient grounds for adopting such provisions, a copy of such resolution being laid before the Board of Trade.

(88.) That the local authority over the inspection of gas meters be in all cases exercised by the county magistrates, except in the metropolitan district, where it should remain under the Metropolitan Board of Works, and in such cities and boroughs as Parliament may determine in respect to the sale of gas, where it should be exercised by the local magistrates.

(89.) That in all such counties, where no Inspector of gas meters may have been appointed, and copies of the gas-measuring standards provided, the duties of comparing, verifying, and stamping gas meters be exercised by the Verifier of weights and measures, who shall be furnished with the requisite gas-measuring standards and other appliances.

(90.) That no copy of the gas-measuring standards be legal that shall not have been reverified by the Standards Department within a period of ten years.

(91.) That no copy of the gas-measuring standards that shall have been altered or readjusted, after verification by the Standards Department, be legal until it shall have been reverified by the Standards Department.

(92.) That provision be made by law for authorizing the Board of Trade, if they should so think fit, to make regulations for the verification of Edinburgh and Dublin, by the chief Verifier of those cities respectively, of copies of the gas-measuring standards used by Inspectors in the several local districts of Scotland and Ireland, by comparison with the primary copies deposited at the two metropolitan cities, and under the directions of the Standards Department.

26TH MEETING, 30 April 1870.

(93.) That upon the verification of the Standards Department of such copies of the gas-measuring Standards as may be provided for any new district, the requisite verification stamps for gas meters, bearing the number of the district, be furnished to the Verifier by the Warden of the Standards, without any charge for the same.

(94.) That from and after a specified period from the passing of the Act, all verification stamps for gas meters which have been furnished from the Standards Department for the use of inspectors of gas meters under the existing law be no longer legal, and be returned to the Standards Department, and that new stamps for verifying gas meters be provided and issued by the Warden of the Standards, at the charge of the department, to such districts as shall require them, bearing the proper number of the district.

(95.) That all such verification stamps shall be and remain the property of the Board of Trade, who shall be empowered to reclaim them upon sufficient grounds of misuse or otherwise.

(96.) That all such duties of verification and inspection of gas meters be exercised according to instructions and regulations to be issued from time to time by the Board of Trade, and that similar powers and authorities in relation to the construction, and the control and supervision of the verification of gas meters, and to the appointment, duties, and apparatus of the inspectors of gas meters, &c., be extended to the Board of Trade, as in the case of weights and measures.

(97.) That no gas meter be legal that shall not have been reverified and restamped within a period of ten years after being fixed and used.

(98.) That all the regulations for licensing or registering makers of weights and measures, &c., and for stamping such weights and measures with the mark of the maker, be made applicable to makers of gas meters, and to gas meters made and sold by them.

(99.) That in the comparison and verification of gas meters, the verification of their indices or registering apparatus, according to the official instructions of the Board of Trade, be included.

(100.) That every gas meter so compared and verified be marked with the number of lights it is constructed to supply, each light being computed to consume five cubic feet of gas per hour, with a pressure equal to a column of water 0·5 inch high.

(101.) That the fees for testing gas meters be regulated in pursuance of a scale to be notified from time to time by the Board of Trade, according to the number of lights which each meter is constructed to supply.

(102.) That the fees for the separate testing of the indices of gas meters be also regulated by the Board of Trade.

§ XI.—*Powers and Duties of the Board of Trade in relation to the Verification and Inspection of Weights and Measures and Gas Meters.*

Considering—

That as regards the whole of the existing system of verification and of inspection of weights and measures and of gas meters, the great and principal defect appears to us to be the want of an efficient central control to give force and unity to local action, as pointed out in the report of the Select Committee on weights and measures, in 1862;

That without such control and authoritative direction, there can be no adequate security to the public for a uniform administration of the law, or a due compliance with its requirements, nor for the proper discharge of the duties imposed upon the local authorities and officers;

That it appears to us that these defects in the existing system may best be remedied by the requisite control and supervision over the local officers, and the duties discharged by them being exercised by a responsible public Department, and that this control be extended to the appointment and remuneration of these officers;

That the necessary powers for these objects should be given by law, and should include the issue from time to time of authoritative instructions for the guidance and government of the local officers;

That in order to make such control effective and to secure that the official instructions are duly carried out and the duties of the local officers adequately performed, it is in our opinion requisite that supervising public officers should be appointed under the authority of such department;

26TH MEETING, 30 April 1870.

That it appears to us to be also expedient for the due protection of the public, that further provision should be made by law for securing, as far as may be, that all weighing and measuring instruments sold for public use should be properly and justly made, in accordance with the established regulations;

That for this object and in order to bring all makers of such instruments under the cognizance of a public Department, and render them in some degree responsible for their instruments, it is expedient that every maker and repairer or adjuster should be registered, and that an annual licence duty should be imposed upon every such maker and repairer or adjuster, thus more completely carrying out the recommendation applicable to gas meters, adopted by the Select Committee of the House of Commons, in 1860, on the Bills for amending the Sale of Gas Act;

We recommend—

(103.) That the Board of Trade be charged with such powers in relation to the appointment, remuneration, and duties of Verifiers and Inspectors of weights and measures, and of gas meters as are mentioned in the preceding recommendations.

(104.) That two or more Inspectors of Standards be appointed by the Board of Trade as officers of the Standards Department, with adequate salaries and allowances for travelling expenses; and that they be subordinate to the Warden of the Standards, and report to him from time to time.

(105.) That each official inspector of Standards be provided with sufficient copies of the official Standards, and such other instruments as may be requisite for comparing and verifying the local Standards and apparatus in the several districts of verification and inspection of weights and measures. That he proceed from place to place within the district assigned to him, previously giving notice to the Verifier, or the chief officer of police, or other chief Inspector, responsible for the duties of inspection of weights and measures, and of gas meters, to have his Standards, balances, and other apparatus ready for inspection at such place and time as may be fixed from time to time by such official inspector, so that each district of verification and of inspection may be visited at least once in each year.

(106.) That it be the duty of the official Inspector of Standards to see that the office accommodation of each Verifier, and the Standards, balances, and other apparatus, are fit and proper for the execution of his duties, as well as the standards and other instruments of the Inspectors of weights and measures and of gas meters; and to ascertain, so far as lies in his power, that the provisions of the weights and measures laws, and the official instructions of the Board of Trade for carrying out the law, are duly complied with by such Verifier and Inspector.

(107.) That in case of any of the local Standards being found to be defective beyond an allowance to be fixed and determined from time to time by the Board of Trade, the official Inspector require them to be immediately adjusted and duly reverified by the Standards Department, provided he deem them fit to be corrected as Standards; and that if he find them to be defective or damaged so that they cannot be made fit Standards, he at once condemn them and cancel the official stamp upon them, so that they can no longer be used as Standards,

(108.) That in all cases after due notice shall have been given to the Verifier or chief Inspector by the official Inspector of Standards, that any of the standards in his custody are defective or unfit for standards, and such standards shall not have been duly adjusted and verified, or replaced with new standards duly verified, after the expiration of three months from the date of such notice, the Board of Trade be empowered, upon the report of the Warden of the Standards, to direct the necessary steps to be taken for publishing in the local newspapers a notice that the district of verification or inspection is not furnished with legal standards of such denominations.

(109.) That in all cases in which such offices, balances, or other apparatus, other than standards, shall be found by the official inspector to be unfit for the proper execution of the duties of verification or inspection, he certify the same in writing to the Verifier or chief Inspector, and require that the necessary steps be taken for placing them in fit condition, and that he shall report accordingly to the Warden of the Standards; that he also require such Verifier or chief Inspector, within one calendar month, to report to the

26HT MEETING, 30 April 1870.

Warden of the Standards what steps shall have been taken in pursuance of the requisition of the official Inspector; and in the event of such steps not being considered satisfactory by the Board of Trade, when reported by the Warden of the Standards, the Board be empowered to authorize him to require the local authorities at once to direct the necessary steps for placing such offices, balances, or other apparatus in fit and proper condition.

(110.) That authoritative instructions be from time to time issued by the Board of Trade to the several verifiers of weights and measures, and inspectors of gas meters, with the view of ensuring uniformity of action in the execution of their duties, and due compliance with the laws as construed by the highest legal authorities.

(111.) That authoritative instructions be also issued to the chief officer of police or other chief Inspector in the several districts of inspection of weights and measures, with the view of ensuring uniformity in the mode of testing the legality of weights, measures, and balances.

(112.) That such instructions comprise all necessary directions for the form, material, and mode of construction of the local Standards, together with the balances, stamps, and other apparatus to be used by Verifiers and by Inspectors of weights and measures, and of gas meters, and for their preservation and use; and include also the scale of tolerance of errors in the official comparison and verification of local Standards.

(113.) That such instructions also comprise directions for the form, material, and mode of construction of all weights, measures, balances, weighing machines, and gas meters to be stamped by the Verifiers of weights and measures, and inspectors of gas meters, and legalized for use; and that the Board of Trade be also empowered to issue from time to time general regulations for these objects.

(114.) That the Board of Trade be empowered to make regulations from time to time for comparing and verifying with the official Standards all weights and measures for scientific purposes or otherwise, in which special accuracy is required, and for charging such fees as shall be fixed by them for the comparison and verification of such weights and measures; but that no fee be charged for the official verification of local Standards.

(115.) That the Board of Trade be also empowered to make such special regulations as they shall deem fit for the testing of large station or other gas meters constructed to pass more than 10 cubic feet of gas at one revolution or complete action of the meter.

(116.) That all instructions and other regulations authorized by law to be issued and made by the Board of Trade in relation to the verification and inspection or otherwise of weights and measures and other instruments, be published in the London, Edinburgh, and Dublin Gazettes, and copies laid before Parliament not later than in the next session after the date of their issue.

(117.) That the Board of Trade be authorized to require the Verifiers and chief officers of police or other Inspectors of weights and measures and of gas meters to make from time to time such returns to the Warden of the Standards in relation to the execution of their duties of verification and of inspection, and in such specified form, as the Board of Trade shall think fit.

(118.) That every maker, repairer, or adjuster of weights, measures, and balances, or weighing machines, and of gas meters, be duly registered in the Standards Office before the 31st January in every year, and a certificate of registry issued to him by the Warden of the Standards, bearing a 5*l.* stamp.

(119.) That the distinctive mark of every such maker be approved and recorded at the Standards Office, before being used.

(120.) That such mark be required to be stamped upon every weight, measure, balance, or weighing machine, or gas meter, before it is sold or used, under penalty.

(121.) That a penalty be imposed by law upon any maker who shall mark any such weight, measure, balance, or weighing machine, or gas meter, without being duly registered.

(122.) That a similar penalty be imposed upon any fraudulent imitation of the mark of such registered maker.

The consideration of the remaining resolutions was postponed to the next meeting.

26TH MEETING 30 April 187

7. A draft of the Fourth Report, which had been prepared at the Astronomer Royal's request by the Warden, was laid by him before the Commission; and it was left to the Warden to have it printed, and to communicate further upon the subject with the Astronomer Royal, in order that it might be considered at the next meeting.

8. Saturday, 14th May, at 11 a.m. was fixed for the next meeting of the Commission.

Adjourned at 4 p.m.

COLCHESTER.

TWENTY-SEVENTH MEETING.—SATURDAY, 14th MAY 1870, at 11 a.m.

27TH MEETING 14 May 18

PRESENT:

The Lord Colchester (in the Chair).
The Astronomer Royal.
The Right Honourable Stephen Cave, M.P.
Sir J. G. Shaw Lefevre, K.C.B.
The President of the Royal Society.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The printed Minutes of the 26th meeting, as corrected, were confirmed.

2. A printed draft of the Fourth Report was laid by the Warden of the Standards before the Commission, copies having been previously distributed.

3. The Warden also laid before the Commission copies of letters from the Treasury to the Foreign Office, and the Board of Trade, dated respectively May 7, 1870, stating that the Treasury had consented to the appointment of the Astronomer Royal and Professor Miller, as delegates from this country to the International Conference at Paris for the construction of new primary metric standards; together with consequent Minutes of the Astronomer Royal, Professor Miller, and himself, on the question of his being associated with them as a third delegate.

4. The consideration of the remaining resolutions contained in Paper XIV.–I., was proceeded with.

With reference to Resolutions (86) and (87), Sir J. S. Lefevre pointed out that as they now stood, they did not sufficiently provide for the inspection of gas meters in boroughs which may be situated in counties where the county magistrates shall have determined not to adopt the Act.

Mr. Cave considered also that the recommendations of the Commission should extend to the compulsory adoption of the Act in all cities or boroughs where gas is manufactured and sold under an Act of Parliament, whether the inspection were placed under the authority of either the county or borough magistrates.

The Commission concurred in these views, and the Warden was requested to make the requisite additions to the Resolutions, as recited in the Fourth Report.

The remaining Resolutions contained in Paper XIV.–I. were then read by the chairman, and, after some discussion, were agreed to, as follows:—

§ XII.—*Other Provisions.*

Considering—

That it is in our opinion requisite that the important changes recommended by us to be made in the existing laws and practice relating to weights and measures should be introduced into Parliament on the responsibility of the Executive Government, and be supported by their authority;

That it has been proved to us that powers have been frequently granted by Parliament in local and personal Acts to corporations and persons, which powers are inconsistent with the provisions of the general laws relating to the verification and inspection of weights and measures and of gas meters, and tend to prevent the establishment of a uniform and efficient system;

We recommend—

(123.) That it is expedient that a Bill be brought into Parliament by the Government, at the earliest period, to amend and consolidate the laws relating to weights and measures and the Standards of weight and measure, and to the sale of gas, and for carrying into effect the preceding recommendations.

(124.) That provisions be also contained in this Bill for carrying out the recommendations of the Commission in their Second Report, relating to the permissive introduction of the Metric system of weights and measures into this country, and in their Third Report, on the abolition of Troy weight.

27TH MEETING, 14 May 1870.

(125.) That all provisions of former Acts which relate to the Standards of weights and measures, and to the legalization, verification, and inspection of weights and measures and gas meters, be repealed, such of the provisions as are not inconsistent with the preceding recommendations being embodied in the amending and consolidating Bill; and that the powers of verification and inspection of weights and measures granted by such Acts, or by charter, custom, or otherwise, shall cease and determine.

(126.) That provision be made for granting such compensation to the Founders' Company for any loss which may be sustained by them through abolition of their ancient rights of verifying brass weights, as the Commissioners of Her Majesty's Treasury shall think fit.

(127.) That tables of all the denominations of legal weights and measures be appended in a schedule to the Bill.

(128.) That the Executive Government take the necessary steps for the adoption of such means as may tend effectually to prevent the provisions of the general law for establishing a uniform system of verification and inspection of weights and measures and of gas meters from being defeated by clauses subsequently introduced into local Acts.

5. Before proceeding with the consideration of the Fourth Report, the Warden said that there were some matters to be brought under the notice of the Commission that might first be disposed of.

He had to report that, in company with Mr. J. Simms, he had been to see whether there was an eligible site for laying down the public standards at Somerset House, as suggested in the letter from the First Commissioner of Works, dated 9 March 1870. Mr. Nutt, the clerk of the works there, was in attendance, and gave such information as they required as to the locality. They found that the length of a chain, divided into tenths, was now roughly laid down upon the parapet of the low wall of the terrace before the river front of Somerset House; this had been done, as he was informed, by Mr. Elliot, of the Strand. The terrace itself appeared to them to be a very suitable place for laying down the public standards, being very similar in its dimensions and general arrangements, as to turf and flagstones, to the site which had been proposed on the south side of Victoria Tower. There is a convenient access to the terrace through the central hall of Somerset House, and the terrace may be closed at the two ends. At the western end, there is a small building, where a labourer resides, who might keep such tools as may be required for adjusting the compared chains, and the mural standards might be placed upon the wall of the building. But he considered that the site is not sufficiently public for the mural standards, which ought to be far more accessible to the working classes, and with this object, he might suggest that such mural standards should be placed on the Thames Embankment, where workmen were frequently passing and might verify their measures.

Professor Miller thought that two sets of mural standards should be put up, one set with the public standards and the other on the embankment.

The Astronomer Royal was of opinion that one set certainly should be with the public chain standards. He would take an early opportunity of inspecting the site at Somerset House, and the decision was left by the Commission to him.

6. The Warden read a letter from Dr. Neumayer, late Superintendent of the Magnetic Observatory, Melbourne, dated 4th May, requesting that his Standard metre, which had already been used by him, and was intended for further use, in pendulum experiments in different parts of the world, might be compared with the official Standard metre; together with his letter in reply, dated 6th May, giving the details and results of the comparison made, and the error of Dr. Neumayer's Standard in terms of the Mètre des Archives.

7. He also reminded the Commission that he had already brought under their notice on 2nd April, communications from Mr. Johnson, respecting the pendulum apparatus constructed by him, and, from Sir Joseph Whitworth, relating to his contact measuring apparatus for measures of length.

Professor Miller said that he would endeavour to see Mr. Johnson's apparatus. He could not recommend that Sir J. Whitworth's apparatus should be used for departmental comparisons, as from its mode of construction, the metal would be too much affected by changes of temperature which could not be accurately noted, and he considered therefore that it was not to be depended on for the scientific measurement of standards of length. But if the apparatus were presented to the Standards Department, it might properly be placed amongst the valuable instruments deposited there, as a specimen of an useful instrument in great repute for engineering measurements.

27TH MEETING, 14 May 1870.

The Astronomer Royal concurred in this opinion, and that the use of the apparatus for official comparisons requiring scientific accuracy should not be entertained. This view was also concurred in by the Commission.

8. The Warden reported to the meeting that a small balance for grain weights was required for the use of the Department, none of the other balances being adapted for very small weights. Under his directions, Mr. Oertling had furnished an estimate for such a balance, with a 10-inch beam, supported on double columns, to carry 30 grains in each pan, and turning with $\frac{1}{1000}$ of a grain; the price being 25*l*. A sketch of the balance was submitted to the Commission, who agreed that it should be at once ordered.

9. He also reported that the adjustment of the avoirdupois standard weights of 1825 to their true Standard weight had been completed by Mr. Oertling, and their reverification after such adjustment would be at once proceeded with.

10. With respect to the completion of the reverification of the Metric weights which might be used as official standards, the Warden stated that, in addition to the two sets from 1 kilogram to 1 gramme, reported in the Minutes of 3rd December 1869, as verified in terms of the Kilogramme des Archives, three smaller sets of Metric weights under 1 gramme to the half milligram, procured from Deleuil at Paris, had now been similarly verified, and would be distinguished respectively as 𝔄, standards of reference; 𝔅, working official standards; ℭ, counterpoises. The details and results of the comparisons were shown to the Commission, and would appear in a printed paper.

The Warden added that it was satisfactory to have complete sets of Metric weights thus accurately verified, as the small weights could now be used in the departmental comparisons of Metric standard weights, and any errors ascertained in Metric quantities. Up to the present time it had been found necessary to use verified Imperial grain weights, and much time was taken up and risk of error incurred, by having to make the subsequent conversions.

11. The Warden next submitted for the inspection of the Commission specimens of two different forms for the new standard coin weights, of the sovereign and half sovereign, one being cylindrical, the height about one-third the diameter, the other quadrangular in the same proportions. Both descriptions were found on trial to be easily lifted by a forceps.

Professor Miller preferred the cylindrical form, which it was agreed should be adopted, together with a suggestion of the Astronomer Royal that the standard of "least current weight" should be readily distinguishable from that of "full weight," by having a broader rim on the engraved surface.

As to verifying and stamping at the Standards Department copies of the new standard coin weights for the use of the public, under the provisions of the Coinage Act recently passed, the Warden said, that with a view of ascertaining the most convenient method of carrying out these provisions, he had been in communication with an officer of the Mint where the coin weights had hitherto been verified and stamped. He found that only two denominations of these coin weights, those of the least current weight of the sovereign and half sovereign, were required for the use of the public, and it would be necessary that the Board of Trade should prescribe the mode of verification and of marking and stamping the weights. He had ascertained that the mode of stamping hitherto adopted at the Mint was by means of a press with a lever handle worked by hand. This method was considered by all parties to be satisfactory, and he thought that it might be adopted at the Standards Department. A fit press and the requisite dies could, he believed, be furnished by the Mint.

Specimens were produced for the inspection of the Commission, of the two descriptions of stamped coin weights now in use, made of brass.

The sovereign weight bore on one side the stamp of the head of the Sovereign, with—

Royal Mint, 1843.	For which he should propose to substitute	Standards Department, 1870.

If the date of the year were thus marked, a new die would be required every year. This might be avoided by substituting "Act 33 Vict. Reg."

27TH MEETING, 14 May 1870.

On the reverse side, the sovereign weight bore,

Curt. weight, 5 dwt. 2½ gr. Sovereign.	For which might be substituted -	Cur^{t}. weight, 122·5 gr., or 7·93787 gram. Sovereign.

Similar alterations might be made in the stamp for the half-sovereign, the weight of—

"2 dwt. 13½ gr." being altered to { 61·125 gr., or 3·96083 gram.

The Astronomer Royal considered that the existing mode of stamping by means of a hand press, and of the marks on the dies should be followed, with such alterations only as were obviously requisite. He found on referring to the Coinage Act, that both the imperial and the metric weight of coins were therein specified, and it was therefore proper that both weights should be marked upon these coin weights.

Professor Miller suggested that the lines of the letters and figures stamped upon the coin weights should be of uniform size and without sharp angles, and generally similar to Colonel Strange's figures.

These proposals in regard to the stamping of coin weights were concurred in by the Commission.

The Warden added that it would also be necessary to make regulations that the weights to be verified should be of a uniform gauge as regards the diameter; and it was desirable that the material of such weights to be stamped should for the present be limited to brass or bronze.

With respect to the amount of the fee to be charged in the Standards Department, after having made due inquiry, and considering the special accuracy required in the weights he was of opinion that the fee for verification and stamping should be 6*d*. for each coin weight.

He would suggest that the following limits of errors to be allowed in the verification of copies of the standard weights for coin should be adopted :—

Denomination of Coin Weight.	Amount of Error allowed, in Excess or Deficiency, for either full Weight or least current Weight.		
	Grain.	Milligram.	
Gold : —Five Pound -	0·0025	0·1685	Or two divisions of each index of the official balances (3) (4), by which such weights would be compared.
Two Pound -	0·0025	0·1685	
One Sovereign -	0·0010	0·0648	
Half Sovereign -	0·0010	0·0648	
Silver :—Crown - -	0·0025	0·1685	
Half Crown -			
Florin - -			
Shilling to Penny	0·0010	0·0648	
Bronze :—Penny - -	0·0025	0·1685	
Halfpenny -			
Farthing - -			

The Commission agreed in the propriety of these suggestions being adopted.

12. The Commission proceeded with the consideration of the Draft Fourth Report.

The preamble and clauses 1 to 16 inclusive were read *seriatim* by the Chairman, and after some discussion and verbal amendments, were agreed to.

13. The further consideration of the Draft Report was adjourned to the next meeting, which was fixed for Saturday next, May 21, at 11 a.m.

Adjourned at 2.30 p.m.

COLCHESTER.

28TH MEETING, 21 May 1870.

TWENTY-EIGHTH MEETING.—SATURDAY, 21st MAY 1870, at 11 a.m.

PRESENT:

The Lord Colchester (in the Chair).
The Astronomer Royal.
The Right Honourable Stephen Cave, M.P.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The printed minutes of the 27th meeting, as corrected, were confirmed.

2. The Astronomer Royal read the following minute relating to the proposed site on the Terrace of Somerset House for the public Standards of length:—

"Royal Observatory, Greenwich, S.E.
20th May 1870.

"On May 19, accompanied by my son, and assisted by the courteous attention of Mr. Nutt, Clerk of Works at Somerset House, I inspected the Terrace of Somerset House, with the view to its possible use as site for public Standards of length, 66 and 100 feet.

28TH MEETING, 21 May 1870.

"For the mere material location of Standards the Terrace is very good. There is sufficiently firm foundation upon the wall a few feet within the Terrace front and parallel to it, abundance of length, easy access by the central hall or by the wicket from Waterloo Bridge, and a convenient room for a working office.

"But there are three serious objections :—

"1. A raised bank would disfigure the Terrace so much that I can hardly believe that the First Commissioner of Works would permit it.

"2. To all persons who have the privilege of walking upon the Terrace, the place of attraction is the front balustrade, and to gain this they would certainly step upon the Standards bank.

"3. It is not to be put out of consideration that the place is distant from the principal resorts of engineers and surveyors.

"I think that this position cannot be adopted.

"G. B. AIRY."

After some conversation, in which reference was made to the considerable changes in contemplation in the office accommodation at Somerset House, the Warden said that his impression was that arrangements might be made by which the Astronomer Royal's objections could be to a great extent obviated; and the matter was left for future consideration, the Astronomer Royal undertaking again to inspect the Terrace, and the Warden to communicate personally with one of the authorities at the Office of Works.

3. The Warden laid the following printed papers before the Commission :—

No. 64 of Appendix VI. to the Fourth Report—On proceedings taken by the Inspector of Weights and Measures of West Middlesex, against offenders for adulterating bread, &c.

Report of a Committee of the Canadian Senate, on establishing a uniform international decimal system of weights, measures, and coinage.

Corrected revise of draft Fourth Report.

4. As to the first of these papers, the Warden said, in reply to the Astronomer Royal, that it contained what appeared to be some useful information on the existing mode of adulterating bread, and of legal proceedings which had been taken to punish the offenders. It was rather as an illustration of the additional duties performed by Inspectors of weights and measures, to which reference had been made in Paper XIV.-I., than as a matter requiring any action on the part of the Commission, that the subject was brought under their notice.

5. With respect to the Report of the Committee of the Canadian Senate, the Warden said that the report had been forwarded to him from Ottawa by Mr. Ryan, the chairman of the committee. After reciting the various steps taken in different countries with the view of establishing an international system of weights, measures, and coins, as shown in the papers of the Standards Commission, with which Mr. Ryan has been furnished, as well as in some other documents, the report referred to the want of uniformity existing in the weights and measures of the four provinces which compose the Canadian Federation, showing that no common standards of weights and measures are established; and that in parts of the Dominion not only Imperial weights and measures, but the ton of 2,000 lbs. avoirdupois, the old English wine gallon, and Winchester corn bushel, and the old French measures of capacity, of which the *minot*, somewhat larger than the bushel, is the unit, as well as the old French measures of length, based on the Paris foot, and the *arpent* for measuring land, are all still legal and in use.

The Committee expressed an opinion that the Colonial Government should lose no time in initiating legislation for adopting the metric system in Canada, at first permissively and conjointly with the Imperial system, as proposed in Great Britain, the example of which might be safely followed.

With respect to a system of international coinage they referred to the proceedings that had occurred in Great Britain upon the subject, and to the decimal silver currency of Canada, now in course of preparation, as being well adapted to an international decimal system to be based on the sovereign, 25-franc piece, and 5-dollar gold piece when assimilated; and they expressed their opinion that such a system would be of great general advantage.

The Astronomer Royal remarked that it was quite evident from the confused state of the weights and measures in Canada, that a reform was much needed.

28th Meeting, 21 May 1870.

6. In placing before the Commission the corrected revise of the Draft Fourth Report, the Warden said that an addition would be found to the concluding paragraph relating to the inspection of coin weights, upon which an expression of opinion on the part of the Commission appeared to be desirable. He read a letter, dated 18th May, from Mr. A. Budd, who signed himself Secretary to the Association of Inspectors of Weights and Measures, asking whether an Inspector was the proper person to sue for the penalty imposed by s. 17 of the Coinage Act of this session; and he stated that by agreeing to the additional paragraph in the Report, the Commission would adopt the views upon this point which he had submitted for their consideration in Paper XXII.

The Commission concurred in the opinion expressed that the inspection of coin weights by the local officers was not called for, and that a tradesman ought not to be liable to so heavy a penalty as 50*l.* merely for using an unstamped coin weight.

7. The Warden read a letter from General Morin, dated 18th May, copies of which he had already communicated to the Astronomer Royal and Professor Miller, announcing the receipt by the French Government of the official answer of the British Government to their invitation to send delegates to the International Standards Commission at Paris, and appointing the Astronomer Royal and Professor Miller; stating also that the Commission would be opened on 8th August, due official notice of which will be given.

He added that the minutes of the Astronomer Royal, Professor Miller, and of himself, which had been alluded to at the last meeting of the Commission, with reference to his being associated with the Astronomer Royal and Professor Miller, as a third delegate, had been officially transmitted to the Treasury by the Board of Trade.

8. He also read a letter, dated 6th May, addressed to the Commission, from Mr. Girdlestone, of New Street, Spring Gardens, suggesting that the proposed international gold coin unit might form a common basis for all measurements whatever of weight and size.

9. The Warden reported the completion of the verification of the Standard litre glass burette, which had been constructed, together with the filling apparatus connected with it, by Mr. Griffin. The details of the process had been submitted to Professor Miller and approved by him, and would be laid in a printed form before the Commission, thus forming a precedent for this new method of verifying glass burettes, which may be constructed to deliver any specified standard measure, either Imperial or Metric, not exceeding a quart or a litre.

10. Mr. Sugg's drawing of the standard cubic foot bottle, with its filling apparatus upon a larger scale, was also exhibited to the Commission; and the Warden explained that this apparatus, when completed, would be available for the larger standard measures of capacity up to a bushel, if they were constructed in a similar form to the cubic foot bottle. Professor Miller expressed his approval of this new apparatus.

11. A working drawing by Mr. Oertling of a vacuum balance of new construction was also exhibited. It was left to Professor Miller and the Warden to decide upon the mode of construction of the new vacuum balance, and to give the necessary instructions to Mr. Oertling.

12. Before proceeding with the further consideration of the Draft Fourth Report, the Warden said, with reference to the recommendation contained in S. XXII. for verifying and stamping balances, that a letter had been received at the Foreign Office from Baron Gevers, the Minister from the Netherlands to this country, requesting information as to the law and practice in force here for verifying balances and other weighing machines. This letter having been referred to the Board of Trade, he had consequently seen Baron Gevers on the subject, and ascertained that the Government of the Netherlands wanted this information to enable them to carry into effect a law passed on 7th April 1869, for verifying and stamping balances and other weighing instruments, which law was to come into operation in 1871. He had reported that at present no law or practice existed of verifying and stamping balances in this country, but that a recommendation on the subject was now under the consideration of the Commission.

13. The Warden laid before the Commission a Draft Order in Council, which had been prepared by him at the request of the Board of Trade, for the legalization of the new Standard weights of $\frac{1}{3}$ and $\frac{2}{3}$ oz. avoirdupois for foreign postal services.

14. The consideration of the remaining clauses of the Draft Fourth Report was resumed by the Commission.

28th Meeting, 21 May 1870

Clauses XVII. to XLII. inclusive, were read *seriatim* by the Chairman, and after discussion, and some corrections, were agreed to, thus completing the Fourth Report of the Commission.

On the suggestion of the Warden, the Commission approved of the final printing of the corrected Report, its circulation for signature, and presentation at the earliest period; and that the issue of the Appendix should follow as soon as its printing could be completed.

15. The Warden said, that in order that their Fifth Report might be finished before the opening of the Paris Commission on 8th August, it was desirable not only to complete as rapidly as possible the verification in the Department of all the new official Standards, but also that the Commission should now proceed to consider what arrangements in relation to the establishment of the Standards Department should be recommended by them in accordance with the intimation contained in the Treasury letter of 26th September 1867, which was referred to in the Minutes of their third meeting in 1st November 1867.

For this object he considered that it would be more satisfactory that a special report should be made by a sub-committee composed of those members of the Commission who were more conversant with official Departments; and that for himself, as being personally interested, he should take no further part than giving the committee every assistance in their inquiries, so that a definite recommendation might proceed from them. He proposed therefore that the Commission should request the Astronomer Royal, Mr. Cave, and Sir J. G. S. Lefevre to act as a sub-committee, to inquire and report what in their opinion should be the staff and salaries in the Standards Department.

This proposal met with the concurrence of the Commission.

16. With regard to their next meeting, the Warden said that the new Standard coin weights now being constructed would be verified as soon as possible; after which it was important that no time should be lost in obtaining their legalization, for which a resolution of the Commission declaring them to be fit Standards would be requisite. A meeting for this purpose might be merely a formal one, as the details of the verification would be first submitted to Professor Miller for his approval. With this exception, it did not at present appear that there was any business for which it would be necessary to call the Commission together, until the departmental work should be so far advanced that they could proceed with the framing of their Fifth Report.

It was left to the Warden to give notice of such formal meeting, and to make arrangements for a sufficient attendance of members of the Commission; Saturday, 4th June, being named as a convenient day, if the verification of the new Standard coin weights should then have been duly completed.

Adjourned at 3 p.m.

COLCHESTER.

TWENTY-NINTH MEETING.—SATURDAY, 16th JULY 1870, at 11 a.m.

29th Meeting, 16 July 1870.

PRESENT:

The Lord Colchester (in the Chair).
The Astronomer Royal.
The Right Honourable Stephen Cave, M.P.
Sir J. G. Shaw Lefevre, K.C.B.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The Minutes of the 28th meeting were confirmed.

2. The Warden laid the following printed Papers before the Commission:—

Complete copy of Appendix to the Fourth Report of the Commission, including the following new Papers:—

App. XI. Translation from the German of the official Regulations and Instructions for carrying out the new weights and measures law of 1868 throughout the North German Confederation. (Paper XXIII. of the Commission.)

App. XIII. Copy of Indian Weights and Measures Act, 1870.

Paper XXII.-I. On the Construction and Verification of new Standard Weights for Coins.

Paper XXVI. On the Number and Denominations of Legal Secondary Standards of Weights and Measures.

Paper XXVII. Correspondence, and opinion of law officers of the Crown, on the validity of the official

29TH MEETING,
1 July 1870.

Indenture of Verification of Local Standard Weights and Measures.
Fourth Annual Report of Warden of the Standards.
Proposed Appendix to Fifth Report (incomplete).

3. The Warden exhibited to the Commission,—

Three new complete sets of Standard Coin Weights, viz.:—

1. Standards for reference; 2. Official Standards; 3. Counterpoises.

One set of new cylindrical Standard Postal Metric Weights, constructed by Messrs. De Grave & Co., of 500 grammes downwards; and two sets of flat cylindrical weights, of 10 to 100 grammes.

New Standard 10 feet and 6 feet steel beds and bars.

New Standard bronze measures of 4 liquid ounces avoirdupois, 2 oz., and 1 oz.

New complete series of Standard glass burettes, from 1 quart and 1 litre downwards, including Standard bottle and half bottle of $\frac{1}{6}$ and $\frac{1}{12}$ gallon; with a series of graduated pipettes.

Set of Imperial Standard measures of capacity for the French Government.

New balance for grain weights, constructed by Mr. Oertling.

A set of Richardson's patent stamped glass measures, sent by Messrs. Couper & Sons, of Glasgow.

Specimens of glass drinking measures, with inspector's stamp affixed on tin ring soldered round the handle, sent by Mr. Gregg, inspector of West Middlesex.

The Pyx box of standard trial pieces of gold and silver, and the old massive keys of the Pyx chamber in the cloister of Westminster Abbey.

A box containing a set of standard hydrometers of the United States, verified by the Standards Department, Washington, and presented by them to this Department.

A working drawing for the new vacuum balance, sent by Mr. Oertling.

A drawing of a portable gas measuring standard of 10 cubic feet, and model of a fusee hydrometrical compensation in substitution of the ordinary cycloidal compensation, sent by Mr. Airey, inspector of gas meters in the Metropolitan district.

A drawing and specification of a proposed new standard test gas meter, sent by Mr. Hartley.

A specimen of an ordinary 100-light meter, constructed to deliver 5 cubic feet of gas per revolution, also sent by Mr. Hartley.

4. Professor Miller exhibited to the Commission,—

A small model of a contrivance for the microscopical comparison of standard measures à bouts, by means of defining lines cut upon glass and reflected through prisms to the defining ends of the measures and the axis of the bar. This contrivance was suggested in substitution for the contact pieces now used, with a view of obtaining greater accuracy.

5. The results of the verification of the standard coin weights, as shown in Paper XXII.–I., were pointed out by the Warden, as well as the determination of the density of the standard gold, palladium-silver, and coinage bronze, of which some of the new standard weights were composed. He was informed by Mr. Oertling that nearly equal proportions of palladium and silver were used in the alloy for the silver coin standard weights. The set No. 1, or Standards of reference, were intended to be constituted the legal standards for coin, and if approved by the Commission as fit standards, upon their passing a resolution to that effect (a form of which he had prepared), the necessary steps would be at once taken for obtaining an Order of Her Majesty in Council to legalize these new coin standard weights.

The Astronomer Royal thought the ascertained errors of these new standard weights very small, and the results of the comparisons were considered by the Commission to be satisfactory.

The following resolution was passed by the Commission:—

Standard Coin Weights.

We have inspected the following new weights of each coin of the realm, which have been constructed in pursuance of section 17 of the Coinage Act, 1870, 33 Vict. c. 10., and under our directions and superintendence, viz.:—

Denomination of Coin.	Standard Weight.		Least Current Weight.	
	Imperial Weight.	Metric Weight.	Imperial Weight.	Metric Weight.
GOLD:	Grains.	Grammes.	Grains.	Grammes.
Five Pound - -	616·37239	39·94028	612·50000	39·68935
Two Pound - -	246·54895	15·97611	245·00000	15·87574
Sovereign - -	123·27447	7·98805	122·50000	7·93787
Half Sovereign -	61·63723	3·99402	61·12500	3·96083
SILVER:				
Crown - - -	436·36363	28·27590	—	—
Half Crown - -	218·18181	14·13795	—	—
Florin - - -	174·54545	11·31036	—	—
Shilling - - -	87·27272	5·65518	—	—
Sixpence - - -	43·63636	2·82759	—	—
Groat or Fourpence	29·09090	1·88506	—	—
Threepence - -	21·81818	1·41379	—	—
Twopence - -	14·54545	0·94253	—	—
Penny - - -	7·27272	0·47126	—	—
BRONZE:				
Penny - - -	145·83333	9·44984	—	—
Halfpenny - -	87·50000	5·66990	—	—
Farthing - - -	43·75000	2·83495	—	—

29TH MEETING,
16 July 1870

and we are satisfied that each of these new weights has been duly verified in the Standards Department, and its weight in relation to the Imperial standard pound, and its equivalent metric weight, accurately determined.

And we declare that in our judgment all these weights are fit and proper to be constituted legal secondary standards by Her Majesty in Council, under the provisions of the Standards Act, 1866; and to be the standard weights for determining the justness of the weight and for weighing such coins of the realm.

6. The Warden referred to resolution (6) contained in section 5 of the Third Report of the Commission, in which they had recommended the legalization, as secondary standards, of the series of decimal avoirdupois grain weights, from 4,000 gr. to 0·01 gr.; these grain weights having been most accurately verified in the Standards Department. In order to carry out this recommendation, he proposed that when reporting to the Board of Trade the resolution of the Commission relating to the standard coin weights, he should also report their recommendation relating to the decimal grain weights, with a view to the simultaneous legalization of both sets of standard weights by Her Majesty's Order in Council; and he submitted to the Commission draft Orders in Council by which this object might be effected.

This course, and the draft Orders, were approved by the Commission.

7. With reference to the new standard coin weights, the Astronomer Royal laid before the Commission an important printed Report in relation to a revision of the laws relating to the Mint and Coinage of the United States, by J. J. Knox, deputy comptroller of the currency, together with a bill for carrying this report into effect, which had been laid before Congress by the Secretary of the Treasury of the United States. The Report is dated 25th April 1870, and it recites the British Coinage Act, 1870, a copy of which is appended to the report. No change is proposed in the standards, either as to the weight or fineness of the existing gold and silver coins, but only certain modifications as to the tolerance. The weight of the coins is proposed to be legally expressed both in metric grammes and in troy grains.

The Astronomer Royal wished to call the attention of the Commission to a provision of law in the United States, which is said not to exist in other countries, for contracting the tolerance of weight allowed in single coins, when a number of coins are weighed. This limitation is already considerable under the existing law, for instance, in a single gold eagle weighing 258 grains of standard gold, the tolerance in weight is $\frac{1}{2}$ grain, or $\frac{1}{516}$th part; whilst in 1,000 gold eagles weighed together, it is only 48 grains or $\frac{1}{5375}$th part. The American Report states that experience has shown that the provision for tolerance in bulk is judicious, and effectual as a check against the issue of uniformly light pieces, and that it had been deemed expedient further to contract the allowance in weighing a number of coins. For example, it is proposed that whilst the allowance in a single gold eagle be in future $\frac{3}{8}$ grain, or $\frac{1}{688}$th part; the tolerance be only 4·8 grains, or $\frac{1}{25000}$th part, when 500 gold eagles are weighed together. It is stated that this new tolerance in bulk would be only about one-fourth of the amount now authorized in gold, and one-third of that in silver, taking into consideration the relative quantities of the several denominations now coined.

29TH MEETING, 16 July 1870.

8. In laying a complete copy of the Appendix to the Fourth Report before the Commission, the Warden said that he had been informed by the Queen's printers that this Appendix would be printed and issued separately from the Report, without having the Report itself prefixed, unless it should be so specially recommended by the Commission.

The Commission unanimously agreed that whilst it was desirable that the Report should have been printed and issued separately, it was also of importance that a copy of it should precede the Appendix, and the Warden was requested to take the necessary steps for effecting this object.

9. With reference to the set of Standard Imperial measures of capacity intended for the French Government, which were now exhibited to the Commission, and were ready for verification, the Warden proposed that an appropriate inscription should be engraved upon them; and the following inscription was approved by the Commission.

PRESENTED BY THE BRITISH GOVERNMENT

1870.

10. The Warden called attention to the two new sets of flat cylindrical metric weights constructed as postal weights, one being of Baily's metal, and the other of ordinary gun metal, nine parts copper and one part tin. It was found that the surface of the Standard weights made of Baily's metal became oxydized, and thus increased the weight. Gun metal was preferred by the manufacturers, and was very much in use for Standard weights, being harder than brass. He was now inclined to think gun metal preferable to Baily's metal as a material for standard weights, although the rigidity of Baily's metal made it valuable for bars constituting Standard measures of length.

Professor Miller concurred in this opinion.

11. Upon examining the specimens of Richardson's patent stamped glass measures, the Commission expressed their entire approval of them, not only as regards the method of stamping, but also of defining the measure by a cut line around the measure a little below the brim; they considered this method of defining the measure far preferable to that of measurement by the brim of the vessel.

At the same time they approved of Mr. Gregg's mode of stamping glass measures, upon a metallic ring soldered round the handle, as applicable to all existing glass measures with handles, or to earthenware measures, such as that exhibited to the Commission on 9th April (*see* Minutes, s. 11).

12. In exhibiting the Pyx box of Standard trial pieces for gold and silver coins, which had just been transferred to his custody by the Treasury in pursuance of the Coinage Act, 1870, the Warden explained to the Commission the mode in which they were used at trials of the Pyx.

He called the attention of the Commission also to the provision in the proposed Coinage Bill of the United States (s. 49), for holding an annual trial of the Pyx there, before a Court presided over by the Judge of the District Court of the United States for the Eastern district of Pennsylvania; and that the requisite fineness of the coins was proposed to be determined by reference to the legal standard of fineness, and not to a material standard, such as the standard trial pieces in this kingdom.

13. The Warden next called the attention of the Commission to the question of establishing a new standard test gas meter.

The need of such a standard test meter, its proposed mode of construction, and the method of using it, had already been brought under their notice in Mr. Hartley's observations of gas-meter testing, a printed copy of which was laid before the Commission on 30th April, and has been distributed to each member.

The Warden read also an application upon this subject from Mr. Airey, the gas meter inspector, which has been officially transmitted to him through the Metropolitan Board of Works, showing the difficulty, inconvenience, and risk of damage to the existing gas-measuring standards, in testing large fixed gas meters, and the desirability of sanctioning the use of a standard test meter in such cases where these large meters cannot be moved to the Inspector's office, and the ordinary gas-measuring standard used for testing them. In the event of a standard test meter not being approved by the Commission, Mr. Airey has applied for the sanction of the Commission to the verification in the Standards Department of a new portable gas-measuring standard of 10 cubic feet, such as that designed by him according to the drawing and model exhibited.

The Warden pointed out that a standard test meter would be far preferable to a portable gas measurer, not only in regard to the bulk of the standard instrument, and the convenience of using it, but also the expense. Mr. Hartley states that whilst a portable gas measurer would weigh 6 or 7 cwt., measure 9 feet in height, and the cost of manufacture be not less than 85*l.*, and a proper carriage and appliances 50*l.* to 60*l.* more, a proper test meter for an inspector, which would weigh little more than 2 cwt., and would measure not more than 2½ feet from front to back, and 3½ feet in height, to be readily carried by two men, or in a truck or cart, would cost from 40*l.* to 45*l.*, and a cheaper meter of the same size about 28*l.*, without a levelling board or fittings.

Mr. Hartley's experiments showed also not only equal but greater accuracy in testing would result in comparing large station meters with a standard test meter.

The estimated cost of a model test meter for the Standards Department, being a wet meter of the size specified, of the best construction, with the interior and all parts exposed to the action of gas or water made of the same metal as that of which the bells of the gas-measuring standards are composed, is stated to be about 65*l.* The relative cost of the three gas-measuring standards of 1, 5, and 10 cubic feet respectively, is 360*l.*, 250*l.*, and 130*l.*

Under these circumstances, the Warden submitted to the Commission the expediency of legalizing the use of such a standard test meter, and of their expressing an opinion to that effect by a formal resolution which he had drawn up for that purpose.

The Commission having examined the drawings and models, and concurring in the views which had been expressed by the Warden, unanimously agreed to the following resolution:—

Standard Test Gas Meter.

Considering—

That large gas meters which are fixed and in use at public buildings, factories, &c., in the several districts of inspection of gas throughout the United Kingdom, cannot be removed to the Inspector's office for the purpose of being tested, except with great difficulty and expense;

That the providing and using portable copies of the existing gas-measuring standards must also be attended with considerable difficulty, risk of damage, and expense to the several localities;

That under the present regulations for carrying out the Sale of Gas Acts, appropriate test meters cannot be employed by Inspectors for the comparison and verification of large station meters, although it has been shown to us that they might be advantageously used for such purposes exclusively, under proper regulations;

That it has also been shown to us that it has been considered necessary throughout the North German Confederation to allow exceptionally the use of a standard test meter in all cases where the employment of copies of the gas-measuring standards is impracticable;

That the legalization of a standard test meter would tend very much to obviate the objections which have been hitherto raised against the general adoption by counties of the Sale of Gas Act, 1859, on the ground of the great expense to be incurred in the several localities;

> We are of opinion that it is expedient to construct a standard test wet meter, which shall pass 5 cubic feet at one revolution, and that it be carefully verified as a standard, with a view to its being legalized by Her Majesty's Order in Council, in pursuance of ss. 6 and 8 of the Standards Act, 1866; and that the Warden of the Standards take the necessary steps for carrying out this recommendation.

14. A copy of M. Tresca's letter to the Warden of the Standards, dated 29th June, was read by the Chairman, containing a list of the countries which had accepted the invitation of the French Government to send delegates to the International Conference at Paris (recited in the Fourth annual Report of the Warden of the Standards), and the names of the members; stating also the steps taken for

29TH MEETING, 16 July 1870.

constructing and verifying at Paris a new line standard metre upon a bar of platinum and iridium.

Professor Miller expressed his disapproval of the mode adopted at Paris of supporting a standard bar under comparison by placing it upon a slab of metal, which must clamp it.

15. As to the question of laying down public standards of length, the following letter from the Astronomer Royal to the Warden was read to the Commission:—

"Royal Observatory, Greenwich,
"MY DEAR SIR, June 11th, 1870.

"YESTERDAY I again inspected the terrace of Somerset House in reference to the practicability of laying down the long standards of length on the turfed portion close to the large pavement which adjoins the main building.

"Measuring roughly from the foot of the steps which debouch from the central hall upon the pavement, I find that westward there are about 42 paces to the first skylight, and eastward about 60 paces to the King's College arch, each of these spaces appears to be free and sufficiently long and generally available on the surface for the location of the standards.

"When I looked at the terrace before, I confined my attention in great measure to the line near the balustrades, because I understood that we should there find foundation upon a longitudinal wall. If I understand rightly the structure of the building the line now examined would cross a number of arches. Remarking that a considerable portion of the line has had a decided "shake," I am almost in doubt whether we could reckon on sufficient stability in that part.

"Combining this with the consideration that a position near Great George Street would be more convenient, I am disposed to wait, especially till we see exactly what alterations will be made near the Victoria Tower.

"I am, &c.
"H. W. Chisholm, Esq. G. B. AIRY."

The Warden said upon the receipt of this letter, he had reported to the Board of Trade, and had suggested his being placed in communication with an officer of the Board of Works with a view of coming to some definite arrangement. Mr. Taylor, one of the surveyors to the Board, had accordingly been directed to communicate with him, but they had not yet met, although he had made an appointment for that purpose. Considerable alterations appeared to be in contemplation at Somerset House, and until it has been decided what was to be done there, as well as on the Victoria Tower site, it was evident no definite steps could be taken for laying down the standards at either place. Whatever site was determined upon, there must necessarily be the firmest possible foundation for the standards.

The Astronomer Royal said he still much preferred the Victoria Tower site, but it was obvious the matter must stand over for the present, and the Warden could communicate with him when the proper time arrived.

16. With regard to the construction of a cylinder and apparatus for a new determination of the weight of a cubic foot of water, the Warden said he had been in communication with Professor Miller, and since with Mr. James Simms, and they had agreed upon the principle of the construction of the measuring apparatus, as suggested by Professor Miller, although some of the details would require further consideration. As to the cylinder, there were two points which he should wish to bring under the consideration of the Commission. The first was the material of the cylinder. Professor Miller preferred glass. Mr. J. Simms said that glass certainly might be used, but there would be great difficulties in working it, and risk up to the last moment that the glass would break. The expense too would probably be ten or twenty times that of metal. Mr. J. Simms therefore strongly recommended the use of gun metal. The second point was the size of the cylinder, and they thought that the best dimensions would be a cylinder as nearly as possible a foot in diameter and in height, this measure being capable of being very precisely verified.

Professor Miller said that his reasons for preferring a glass cylinder were that it would give a very hard and evenly polished surface, with great durability, and not be liable to change from oxydation, and that it would have sufficient strength of substance without being too heavy. However, under the circumstances, perhaps it would be better to use gun metal, although if made sufficiently substantial to avoid the risk of indentation, it might be inconveniently heavy. It was very desirable for the sake of accuracy in weighing that the specific gravity of the cylinder should not much exceed that of water.

29TH MEETIN 16 July 18

The Astronomer Royal thought that the dimensions of a foot were rather too large, and that difficulties might consequently arise with a cylinder of this size.

The Warden exhibited a drawing of the brass cylinder used at Paris in 1795 by M. Lefevre Gineau for determining the weight of a cubic decimetre of water, reference to which is made in Appendix VI. to the Second Report of the Commission. This brass cylinder was about 9½ British inches in height and diameter. If 9 inches, or a quarter of the Imperial yard, were now determined upon for the dimensions of the gun-metal cylinder, this measure could be verified as accurately as the foot measure.

It was left to Professor Miller and the Warden to decide upon the arrangements for carrying the matter out.

17. The question of a more uniform normal temperature and barometric pressure for the comparison of standards was brought under the notice of the Commission by the Warden, who read a paper on the subject, stating some existing anomalies, and concluding with some proposed resolutions for the consideration of the Commission.

After some remarks from the Astronomer Royal and Professor Miller, the Astronomer Royal said that his impression was that the Commission could not take any action upon this question, but he would take the Warden's paper home with him and consider it.

18. With regard to the preparation of the Fifth Report of the Commission, which would deal with the remaining points referred to them by Her Majesty in the Royal Warrant of appointment, viz., the establishment and business of the Standards Department, including the completion of the verification of all the official standards, the Warden said that at Sir J. G. S. Lefevre's request he had laid before him the requisite information for enabling the sub-committee appointed at the last meeting of the Commission (*see* Minutes, s. 15) to report specially upon the establishment of the Standards Department. He hoped therefore that this portion of the subject of the Fifth Report would be at once dealt with.

The reverification of all the Exchequer Standards transferred to the Board of Trade had already been officially reported to the Commission, and great progress had been made in the verification of all the new standards.

The comparisons of all the subdivisions of the Imperial yard and of the metre marked on the new subdivided standard of length SS were now completed, and the value of a division of each of the four micrometers of the comparing apparatus had been finally determined from the ascertained exact value of the subdivisions of the inch. The new standards of 10 feet and 6 feet were ready for verification, and awaited only proper supports for placing them under the microscopes. These supports had been ordered from Messrs. Troughton and Simms, and were daily expected.

The verification of the whole series of metric weights had been completed, as well as the comparisons of the metric measures of capacity.

The verification of the whole series of standard glass burettes, both of Imperial and metric measure, was also nearly completed.

It is hoped that the official statements relating to the verification of all these standards will be laid, in a printed form, before the Commission before Saturday, the 30th July.

The reverification of all the new standards will thus have been reported to the Commission, except that of the two new brass metres from Paris, one a metre à traits, and the other a metre à bouts, the new standard test gas meter, and the public and mural standards of length. To these operations may be added, the important work of re-determining the weight of a cubic foot of water, by means of the new cylinder and measuring apparatus.

The coefficient of expansion of each of the new brass bars upon which the metres are marked has been accurately ascertained at Paris, and only a few more observations are required finally to determine the length of each of these new standard metres in terms of the primary Mètre des Archives. In the meantime, the length of the metre marked on the subdivided standard bar SS has been determined from the two platinum metres of the Royal Society with sufficient exactness, as the basis of all comparisons of metric measures of length for commercial purposes in this country.

The verification of the new standard test gas meter, which is yet to be constructed, thus appears to be the only hindrance to the immediate preparation of the Fifth Report of the Commission, and to its consideration by the Commission at their next meeting on 30th July, so far as regards the including in the Report, according to the terms

29TH MEETING, 16 July 1870.

of the Royal Warrant of appointment, a declaration that all the official standards and new standards have been proved to be in perfect condition and fit standards for the comparison and verification of any weights and measures, in pursuance of the Standards Act of 1866. As the new test meter is only an auxiliary instrument, to be verified by the existing gas-measuring standards, the Commission will perhaps consider that the work may be left to the responsibility of the Standards Department, a special report of the verification being made to the Astronomer Royal and Professor Miller, and their approval obtained, as the more experienced scientific members of the Commission. The same consideration may apply to the comparing operations of the public and mural standards, and to the new cylinder and measuring apparatus.

The first point upon which he wished for the instructions of the Commission was therefore whether the preparation of the Fifth Report should be delayed until the verification of the new standard test gas meter, and the other recited comparisons, should have been completed.

A second point was of some importance, whether the Fifth Report should be the final Report of the Commission, as completing their reports upon the several subjects specifically referred to them in the Royal Warrant of appointment, or whether any further duties were imposed upon the Commission.

The question of these further duties had already been brought under the notice of the Commission, particularly at their second meeting on 19th July 1867, when it was considered that although a temporary Commission, it might be inexpedient to bring it to a final close, and that it might be revived for special occasions; and also at the meeting of 19th November 1869 (Minutes, s. 23), as bearing upon,—

1. The preparation of general regulations and official instructions to inspectors, &c. of weights and measures, under the proposed new Weights and Measures Act.
2. The consideration of any important questions that may arise in relation to international metric standards for the United Kingdom, in connexion with the International Conference at Paris.

He would add also,—

3. The periodical comparison with the Imperial standards of the three Parliamentary copies deposited at the Royal Mint, with the Royal Society, and in the Royal Observatory at Greenwich, respectively.

The Warden read the terms of the Royal Warrant of appointment in reference to these three points, together with s. 2 of the Standards Act, 1866, requiring the Board of Trade to compare once in every ten years after the passing of the Act, the three Parliamentary copies of the Imperial Standard. The Commission would remember that the surviving members of the Standards Committee of 1842 were specially assembled in July 1864, and then compared the three Parliamentary copies of the Standard Pound with the Imperial Standard of weight, although no comparison was made of the Parliamentary copies of the standard yard with the Imperial standard of length. It was probable that several important questions of a scientific or chemical character would arise in the preparation of the official regulations and instructions, in which the opinions and decision of the scientific members of the Commission would be desirable.

The Astronomer Royal said he considered that upon the completion of the Fifth Report the Commission would terminate, all the objects specifically referred to them by Her Majesty having been accomplished. For himself, he had felt very much the pressure of attending the meetings of the Commission, and must ask to be released from any further attendance. He would give his attention to any special points that might arise which should be referred to him in writing, but could not give his personal attendance. The further operations alluded to by the Warden might be carried out in the Standards Department, under the authority of the Board of Trade.

Sir J. G. S. Lefevre thought it very probable that questions would arise connected with the recommendations in the Reports of the Commission, that might require a further reference to them, and upon which it might be considered advisable for their opinion to be given. It was certain also that there would be many matters which would be brought under the notice of the Astronomer Royal for his opinion or decision, and thus the work would be thrown more upon him personally than if the Commission continued to exist. However, it was usual that Royal Commissions should die a natural death as soon as they had finished their inquiries and reported upon the matters referred to them, and he did not see how they could make themselves an exception to the general rule.

29TH MEETING, 16 July 1870.

Mr. Cave thought their duties as Commissioners ceased when they had performed the duties specified in the Royal Warrant of appointment, and that all the duties and responsibilities of issuing official regulations and instructions to inspectors, &c., as well as the comparisons of the Parliamentary copies of the Imperial Standards, and of other Standards, rested with the Warden and the Board of Trade.

The Commission therefore agreed that their duties would cease with the presentation of their Fifth and final Report.

The Warden was requested to prepare a draft of the Fifth Report in consultation with the Astronomer Royal.

19. The progress of printing the Appendix to the Fifth Report was stated by the Warden. Many of the papers were already finally corrected for press, and all the remaining papers would soon be in the hands of the Queen's printers, except Appendix XI., relating to the verification at Paris of the Metric Standards for the department, which must be delayed until he could attend there for the completion of the observations. In the meantime the same course could be adopted as with the Fourth Report, to issue the Fifth Report separately from the Appendix.

20. Saturday, 30th July, was fixed upon for the next meeting of the Commission, when it was hoped that they might agree upon the Fifth and final Report.

21. After inspecting the new rooms in the Tower, and the new Standards and apparatus, the Commission adjourned at 3.30 p.m.

COLCHESTER.

THIRTIETH MEETING.—SATURDAY, 30th JULY 1870, at 11 a.m.

30TH MEETING, 30 July 1870.

PRESENT:

The Lord Colchester (in the Chair).
The Astronomer Royal.
The Right Honourable Stephen Cave, M.P.
Sir J. G. Shaw Lefevre, K.C.B.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The Minutes of the 29th meeting, as corrected, were confirmed.

2. The following printed Papers were laid before the Commission by the Warden:—

Pamphlet on "Correct Gas Measurement," by Mr. G. Glover.

Paper XIX.—1. Further verification of standard Imperial measures of length (Appendix VI. 2. to Fifth Report).

Paper XXVIII. On the proposed construction and use of standard Test Gas Meters (Appendix VII. 2. to Fifth Report).

Paper XXIX. On more uniform normal Thermometric Temperature and Barometric pressure in comparisons of standards (Appendix XV. to Fifth Report).

Draft of Fifth Report of the Commission.

And the following Papers to be printed:—

Paper XVIII.—1. Further verification of standard Imperial measures of capacity (Appendix VI. 2 to Fifth Report).

Paper XXIV. Verification of official standard Metric weights and measures (Appendix XII. to Fifth Report.)

Complete copy of Papers on the International Standards Conference at Paris (Appendix XIII. to Fifth Report.)

Paper XXX. Scale of errors to be allowed in the official comparisons of standards (Appendix XVI. to Fifth Report).

Paper XXXI. List of standard weights and measures deposited in the Standards Department (Appendix XVIII. to Fifth Report).

Paper XXXII. List of Balances and Comparing or auxiliary Apparatus of the Standards Department (Appendix XIX. to Fifth Report).

And complete list of Papers laid before the Standards Commission.

Some explanations were given by the Warden in regard to the papers thus presented. He laid also before the Commission a complete list of the proposed Appendices to the Fifth Report.

3. In reporting the progress of business, the Warden said with respect to the International Standards Conference at

30TH MEETING, 30 July 1870.

Paris, that as the Commission and Board of Trade attached so much importance to the nomination of three delegates from this country to the Conference, the Treasury had sanctioned his appointment, together with that of the Astronomer Royal and Professor Miller. A copy of the Treasury letter was contained in the Papers now laid before the Commission.

He also read a letter from M. Tresca, in answer to his inquiry, stating that notwithstanding the war, the Conference would meet at Paris as proposed, on 8th August. He had communicated officially on the subject with the Board of Trade with the view of making all the necessary arrangements.

4. The Warden stated that he had received a letter from Dr. Von Steinheil to inform him of the completion of the construction of the crystal copy of his kilogram, and its satisfactory verification. He had requested Dr. von Steinheil to keep it in his custody until there was an opportunity of safely conveying it to this country.

The only charge made for constructing and verifying the kilogram was for the mechanical work employed, amounting to 250 florins, or about 22*l.*, Dr. von Steinheil and Professor Voit having given their services gratuitously. He proposed, as an acknowledgment due to them, that the thanks of the Commission be given to these two gentlemen for their valuable and honorary scientific labours in the construction and verification of this crystal kilogram for the Standards Departments.

The Commission concurred, and requested the Warden to convey the thanks of the Commission to Dr. von Steinheil and Professor Voit accordingly.

5. As to the public standards of length to be laid down, the Warden said he had communicated with Mr. Taylor, of the Office of Works, and they agreed that the matter had better stand over for the present. Mr. Taylor suggested that upon the completion of the quadrangular Court of the Foreign and India Offices by the erection of the new buildings, an eligible site might be found there for the public standards. The matter was thus left by the Commission in the hands of the Warden.

6. With reference to Paper XXVIII., on the construction and use of standard Gas Meters, the Astronomer Royal expressed his concurrence in the proposal that standard dry meters for testing purposes, as well as wet meters, should be furnished to the Standards Department.

The Warden read the words of s. 2 of the Sale of Gas Act, 1859, relating to the gas-measuring standards to be used by local inspectors, and the Commission concurred in the Warden's opinion that standard Test Meters were included in the provisions of the Act.

The Commission then agreed to the following resolutions:—

> We have considered the question of the construction and use of a standard test meter to pass one cubic foot of gas in one revolution or complete action of the meter, and we are of opinion that such a standard test meter, being a wet meter, should be constructed, with a view to its being legalized by H.M. Order in Council, pursuant to ss. 6 and 8 of the Standards Act, 1866.
>
> We are also of opinion that it is expedient that two standard test dry gas meters, to pass respectively two and a half cubic feet and half a cubic foot in one revolution or complete action of the meter, should be constructed and deposited in the Standards Department, in order that comparisons may be made from time to time as to the due accuracy of measurement of the wet and dry meters respectively, and as to their relative advantages and disadvantages as test meters; and that the Warden of the Standards take the necessary steps for carrying out this recommendation.

7. The subject of the number of legal denominations of secondary standards of weights and measures, as contained in Paper XXVI., was then brought under consideration, and the following resolution was passed by the Commission:—

> We have considered the proposed list of legal denominations of secondary standards of weights and measures contained in Paper XXVI. which has been laid before us by the Warden of the Standards, and we approve of the same being adopted.

8. With respect to Paper XXX., on the scale of errors to be allowed in the official comparisons of standards, the Warden referred to the provisional scale now adopted in the Department under the sanction of the Commission, and pointed out that in their Warrant of appointment, they were directed to report what scale should in their opinion be allowed; and that s. 5 of the Standards Act of 1866 enacted that the amount of error to be tolerated should be defined by H.M. Order in Council. In Paper XIV.–I., p. 28, he had suggested that it was desirable to modify the provisional scale, in accordance with the later experience of the officers of the Department, and especially to limit the error allowed in deficiency to one half the allowance in excess, so far as regards standard weights. The scale now submitted for the approval of the Commission was drawn up in order to carry into effect the views he had thus expressed. It was limited to the Imperial system of weights and measures, as it was proposed by the Commission that in the law for legalizing metric standards, authority should be given to the Board of Trade to make regulations from time to time for the allowance of error in all comparisons of standards.

30TH MEETING, 30 July 187

The Astronomer Royal approved of the proposed modification of the scale, and the principle of allowing in comparisons of standard weights, twice the allowance in excess that was allowed in deficiency.

Professor Miller considered the French system of allowing errors in excess only as objectionable, as it caused standard weights to be made much too heavy.

The following resolution was then agreed to by the Commission:—

> We have considered the scale of errors proposed to be allowed in the official comparisons of standards contained in Paper XXX., laid before us by the Warden of the Standards, and we approve of this scale being submitted to Her Majesty in Council, to be legalized in pursuance of s. 5 of the Standards Act, 1866.

9. In calling the attention of the Commission to Paper XXIX., on the question of a more uniform normal thermometric temperature and barometric pressure in comparison of standards, the Warden said that upon receiving the Astronomer Royal's approval, he had caused the Paper to be printed and circulated. He had some doubt as to the temperature of the mercury in the barometer which it might be expedient to adopt. It was customary to reduce the temperature to 32° F., although there was no legal authority for so doing, and the law appeared to acknowledge *no other temperature than 62° F. But the general practice* of reducing the temperature of the mercury to 32°, and the fact of all the tables of reduction now in use being constructed upon this principle, would probably render it advisable to break through the strict rule of uniformity and to adopt the temperature of 32° F. for this purpose.

The Astronomer Royal said that the barometer was universally reduced to the freezing point, especially in meteorological operations, and that no change in this respect appeared to him to be required.

Professor Miller concurred, and the following resolutions were agreed to:—

Considering that with respect to all comparisons in air of standard Imperial weights and measures in which scientific accuracy is needed, it is desirable to adopt both in the Standards Department, and generally in this country, a more uniform normal temperature and barometric pressure, to which the several comparisons shall be reduced,—

> We are of opinion that whilst, in the case of primary standard weights, it is necessary to reduce all weighings to the weight in a vacuum, in all cases of weighing either Imperial or metric weights in air, when the weighings are required to be reduced to air of a normal thermometric temperature and barometric pressure, the standard temperature of 62° F. (=$16\frac{2}{3}$° C.), and the standard barometric pressure of 30 inches (=761·986 mm.) at or to be reduced to *the temperature of 32° F.*, be adopted, *and that all commercial* weights be regulated accordingly.
>
> That whilst for the primary standard metre, the French standard temperature of 0° C., or 32° Fahr., be taken, at which temperature the official standard metre is laid down, all departmental comparisons with the official standard metre be made at ordinary temperatures of the air, in like manner as comparisons with the official Imperial standard measure of length, the standard temperature for all such comparisons being taken to be 62° Fahr.
>
> That in all determinations of standard Imperial measures of capacity, either for dry goods, liquors, or gases, the above-mentioned standard temperature of 62° Fahr. and barometric pressure of 30 inches be adopted, and that this standard temperature be applicable to the temperature of the air, liquid, or gas, to be noted in such determinations.
>
> That, with regard to metric measures of capacity, whilst the standard capacity of the primary standard

30TH MEETING, 30 July 1870.

measures of each denomination be determined with reference to the weight of water at its maximum density (generally taken at 4° C., or 39·2° F.), contained in each standard measure respectively, all comparisons with these standards of local standards or commercial measures be made at ordinary temperatures, the standard ordinary temperature both of the air and of the water contained in such measures being taken to be 62° F.

That it is expedient that provision be made by law for the adoption of such normal temperature and barometric pressure.

10. Before proceeding to the consideration of the Fifth Report, Sir J. G. S. Lefevre stated that the press of parliamentary business had prevented his completing the special report of the sub-committee upon the establishment of the Standards Department, but he hoped that the report would be ready to be laid before the Commission on Wednesday next. He suggested that as it was on a special subject, and would not be signed by the Warden, it might be more conveniently added as a postscript to the Fifth Report. This course was approved by the Commission.

11. The Commission then entered upon the consideration of the draft of the Fifth Report, as prepared by the Warden of the Standards, and it was read by the Chairman, paragraph by paragraph. After discussion and deliberation, various amendments were made, and the Report, as amended, was agreed to.

12. The Commission inspected the Imperial standards of length and of weight in the strong room of the Standards Office.

13. After appointing another meeting of the Commission at 2 p.m. on Wednesday, 3rd August, to receive the special report of the sub-committee, and to deal with the remaining business, the Commission adjourned at 3 p.m.

COLCHESTER.

THIRTY-FIRST MEETING.—WEDNESDAY, 3rd AUGUST 1870, at 2 p.m.

31ST MEETING, 3 AUG. 1870.

PRESENT:

The Lord Colchester (in the Chair).
The Astronomer Royal.
The Right Honourable S. Cave, M.P.
Sir J. G. S. Lefevre, K.C.B.
Professor W. H. Miller, F.R.S.
The Warden of the Standards.

1. The minutes of the 30th meeting, as corrected, were confirmed.

2. The sub-committee appointed on 21st May to report on the Standards Establishment, sat and agreed on their report, which will appear as a postscript to the Fifth Report.

3. The copy of the Fifth Report, for presentation, was signed by the Commissioners who were present.

4. The Warden submitted to the Commission that Mr. Mudge, the temporary clerk in the Standards Department, has been much employed in the abstracts of the numerous returns from the local inspectors, and other work for the Commission, and had continually been engaged after office hours. He proposed, therefore, that a gratuity of 30*l*. be recommended by the Commission to be given to Mr. Mudge. This was agreed to by the Commission.

5. Professor Miller reported that, in company with the Warden, he had inspected Mr. Johnson's Pendulum measuring apparatus. Although an ingenious and well constructed instrument, to be practically available it would require very elaborate observations and computations, and he was of opinion that it was not the kind of apparatus which should be deposited in the Standards Department. The Commission concurred in this opinion.

Adjourned at 3.30 p.m.

G. B. AIRY.

COMPLETE LIST of PRINTED PAPERS laid before the STANDARDS COMMISSION, and referred to in the MINUTES of PROCEEDINGS.

Number and Title of Paper.	Date.	No. of Appendix in Reports of the Commission.
I.—PAPERS DELIVERED BY THE ASTRONOMER ROYAL.		
Memorandum on the policy of introducing Metric Standards	1867, Jan. 1	2nd Rep., App. 1.
„ „ proposal of the Master of the Mint to abolish Troy Weight, &c.	1869, March 8	3rd „ 2.
Further do. do.	„ June 1 „ „ 18	„ „ 8.
II.—PAPERS DELIVERED BY THE MASTER OF THE MINT.		
Proposal to abolish Troy Weight and substitute Metric Weights	„ March 6	3rd „ 1.
III.—PAPERS DELIVERED BY THE WARDEN OF THE STANDARDS.		
PAPER I.—Preliminary Paper. List of existing legal standards; proposed additions, &c.; with Appendices	1866, Oct. 5	5th „ 2.
„ II.—Preliminary Paper. Proposed mode of Comparison and Reverification of Official Standards	„ „ 12	„ „ 3.
„ III.—Preliminary Paper. On the business of the Standards Department, and duties of its Officers, particularly in relation to the Local Inspection of Weights and Measures, with Appendices, including Appendix G., cases illustrating the working of the existing Law	1867, Jan. 11	„ „ 1. 4th „ 1. „ „ 6.
III.—1. Addenda to Appendix G.	„ Feb. 18	„ „ 6.
III.—2. „ „	1868, May	
III.—3. „ „	1869, Jan.	
III.—4. „ „	„ May	
III.—5. „ „	1870, Jan.	
III.—6. „ „ Inspection of Post Office, Customs, and Excise Weights and Measures	„ „	„ „ 8.
Standard Weights of 1/3 and 2/3 oz. for Foreign Postal Service	„ „	„ „ 9.
III.—7. „ „ Working of Sale of Gas Acts	„ „	„ „ 7.
III.—8. Additional Paper on the Establishment of the Standards Department	„ June 10	5th „ 1.
„ IV.—Preliminary Paper on Allowance of Error in Official Comparisons of Standards, and Question of Allowance in Commercial Weights and Measures	1867, Jan. 19	4th „ 2.
„ V.—Reverification of Official Standards of Avoirdupois and Troy Weight	„ April 24	5th „ 4.
„ VI.—Relation of the Length of the French Metre to the Imperial Standard Yard; with Appendices	„ July 6	„ „ 9.
„ VII.—Translation from the German of General Baeyer's Paper on Changes in Length and Co-efficients of Expansion of Standard measuring bars	„ Aug. 7	„ „ 10.
„ VIII.—On expenses connected with the Official Reverification of Local Standards, and on the Local Reverification of these Standards	1868, March	4th „ 6.
„ IX.—On the Weights and Measures of Scotland and Ireland	„ Feb. 12	„ „ 5.
„ X.—Reverification of Standard Bullion Weights, based on Primary Platinum Standards; principles and practice of comparing Standard Weights differing in density, &c.	„ June 29	5th „ 5.
X.—1. Further Reverification of Official Standard Bullion Weights, and other Standard Weights	1869, Jan. 2	
X.—2. Further Verification of Standard Imperial Weights	1870, April 8	
„ XI.—Memorandum on Progress of Business of the Commission	1868, Feb. 1	Not reprinted.
„ XII.—Abstracts of Returns from Inspectors of Weights and Measures in Great Britain, for 1866	„ Nov. 18	4th Rep., App. 3.
„ XIII. Do. Ireland, for 1866	„ April 14	„ 4.
„ XIV.—Summary of information relating to Inspection of Weights and Measures, with some practical suggestions for its improvement	1869, May 4	„ 12.
XIV.—1. In continuation; with revised suggestions and proposed resolutions, after considering evidence laid before the Commission	1870, Jan. 24	
„ XV.—On the Law and Practice of the Metric System of Weights and Measures in France	1868, April 3	2nd „ 2.
„ XVI.—On the Question of the Introduction of the Metric System into the United Kingdom, with references to its introduction into other countries	1869, Feb. 22	„ 3.
„ XVII. (and XVII.—1, 2, and 3.)—On the Question of abolishing Troy Weights, and proposed substitution of Metric Weights	„ Mar., Dec.	3rd „ 3, 5, 9.
„ XVIII.—Reverification of Official Standard Imperial Measures of Capacity	1870, March 24	5th „ 6.
XVIII.—1. Verification of New Imperial Standard Measures of Capacity	„ July 27	
„ XIX.—Reverification of Official Standard Yard, and comparisons of other Standard Imperial Measures of Length	„ March 24	„ 7.
XIX.—1. Verification of New Imperial Do.	„ July 15	

Number and Title of Paper.	Date.	No. of Appendix in Reports of the Commission.
Papers delivered by the Warden of the Standards—*continued.*		
PAPER XX.—Reverification of Official Gas Measuring Standards	1870, April 2	5th Rep., App. 8.
„ XXI.—On the Standard Weights and Measures of the United States of North America	„ Feb. 21	4th „ 10.
XXI.—1. P.S. to Do. Do.	- - -	
„ XXII.—On the Provisions of the Coinage Act, 1870, relating to Standard Weights for Coin	„ March 21	5th „ 5.
XXII.—1. Construction and verification of New Standard Coin Weights	„ July 12	
„ XXIII.—Translation from the German of the Official Regulations and Instructions relating to the Metric System of Weights and Measures in the North German Confederation	„	4th „ 11.
„ XXIV.—Account of the Verification at Paris of Metric Standards of Length, Weight, and Capacity for the Standards Department	1869–1870	5th „ 11.
„ XXV.—Verification of the Official Standard Metric Weights and Measures	1870, Oct. 28	„ „ 12.
„ XXVI.—Number and Denominations of proposed Legal Secondary Standards of Weights and Measures	„ June 25	„ „ 17.
„ XXVII.—On the legal validity of the Official Indenture of Verification of Local Standards; Correspondence, and Opinion of Law Officers of the Crown	„ July	„ „ 14.
„ XXVIII.—On the proposed construction and use of Standard Test Gas Meters	„ „	„ „ 8.
„ XXIX.—On a more uniform Normal Thermometric Temperature and Barometric Pressure in Comparisons of Standard Weights and Measures	„ „ 15	„ „ 15.
„ XXX.—Scale of Errors proposed to be allowed at the Standards Department, in the Comparison of Standard Weights and Measures	„ „ 30	„ „ 16.
„ XXXI.—List of Standard Weights and Measures deposited in or being constructed for the Standards Department	„ „ 30	„ „ 18.
„ XXXII.—List of Balances and other comparing or auxiliary Apparatus of the Standards Department	„ „ 30	„ „ 19.
„ XXXIII.—Verification of New Imperial Standard Measures of 6 feet and 10 feet of additional New Standard Weights, and of Standard Test Gas Meters	1871, April 8	„ „ 20.
Other Papers, viz. :—		
On the Construction and Verification of the new Swiss Standard of Length, derived from the Metre	1869, April 3	2nd „ 5.
On the relation of the Kilogram, the Unit of Metric Weights, and of the Litre, the Unit of Metric Capacity, to the Metre, the Unit of Length, and fundamental base of the Metric System	„ „ 3	„ „ 6.
Tables of Decimal Equivalents of Imperial and Metric Weights and Measures	„ May 12	„ „ 7.
Case for opinion of Law Officers of the Crown, and their opinion on the legality of officially verifying Metric Weights and Measures, &c.	1868, July 25	5th „ 2.
Papers relating to the International Conference at Paris for constructing, &c. new Metric Standards :—		
1. Copy of Resolution of International Geodesical Conference at Berlin	1867, Oct. 7	5th „ 13.
2. Report of Commission of Academy of Sciences at St. Petersburg	1869, May 20	
3. Report of Commission of Academy of Science at Paris	„ Aug. 23	
4. Report to the Emperor of the French, by the Minister of Commerce, &c.	„ Sept. 1	
5. Letter of M. de Jacobi to the Secretary of the French Academy	„ „ 12	
6. Paper of ditto read before the French Academy	„ Oct. 19	
7. Translation of Reports of Standards Commission, Berlin	„ Dec. 29	
8. Copy of Letter from the French Ambassador at London to the Earl of Clarendon	„ Nov. 19	
9. Reference to Minutes of the Commission of December 21, 1869, and April 2, 1870	1870,	
10. Treasury to Board of Trade, enclosing copy of 11	„ May 7	
11. Treasury to Foreign Office, appointing the Astronomer Royal and Professor W. H. Miller as Delegates to the Paris Conference	„ „	
12. Minutes of the Warden of the Standards, the Astronomer Royal, and Professor W. H. Miller, on appointment of a Third Delegate	„ May	
13. Treasury to Board of Trade, appointing Mr. Chisholm as Third Delegate	„ „ 30	

STANDARDS COMMISSION.

APPENDIX TO FIFTH REPORT.

PAPERS DELIVERED BY THE WARDEN OF THE STANDARDS.

CONTENTS.

Page

PPENDIX I.—On the business of the Standards Department and the duties of its officers:

1. Preliminary paper, dated 11th January 1867 - - - 2

2. Additional paper on the establishment of the Standards Depart-

other official standard weights; dated 2nd January 1869 - 47

3. Further verification of official standard Imperial weights; dated 8th April 1870 - - - 59

4. On the standard weights for coins, including construction and verification of new standard weights; dated 21st March 1870 - - 76

„ VI.—Part I. Reverification, &c. of official standard Imperial measures of capacity; dated 24th March 1870 - 79

Part II. Completion of verification of new official measures of capacity; dated 27th July 1870 - - - 91

„ VII.—1. Reverification, &c. of official standard yard and other standard Imperial measures of length; dated 24th March 1870 - - - 97

Page

APPENDIX VII.—*cont.*

2. Completion of verification of new official standards of length; dated 15th July 1870 - - - 106

„ VIII.—1. Reverification of gas measuring standards: dated 2nd April 1870 - 127

„ XVI.—Scale of errors to be allowed at the Standards Department in the comparison of imperial standard weights and measures; dated 30th July 1870 - - - 212

„ XVII.—Number and denominations of legal secondary standard weights and measures; dated 25th June 1870 - - - 219

„ XVIII.—List of standard and other weights and measures deposited in the Standards Department; dated 30th July 1870 - 222

„ XIX.—List of balances and other comparing or auxiliary apparatus of the Standards Department; dated 30th July 1870 - 226

„ XX.—Verification of new Imperial standard measures of 10 feet and 6 feet; of new standard glass and coin weights; and of standard test gas meters; dated 1870-1 229

APPENDIX TO FIFTH REPORT OF STANDARDS COMMISSION.

ERRATA.

Page 6, line 3 from bottom, *for* “ see page 6 ” *read* “ see page 9.”
„ 19, last line, *for* “ See App. V., p. 36 ” *read* “ See App. V., p. 39.”
„ 40, right-hand margin, *for* “ Reduction of weights ” *read* “ Reduction of weighings.”
„ 53, right-hand margin, *read* “ Standard weight of bullion standards.”
„ 60, line 36 from top, *for* “ p. 55 of Appendix V.” *read* “ p. 57 of Appendix V.”
„ 64, line 30 from top, *for* “ p. 53 of Appendix V.” *read* “ p. 54 of Appendix V.”
„ 76, line 20 from bottom, *for* “ Paper X.–1, p. 13 ” *read* “ App. V., p. 53.”
„ 97, line 12 from top, right-hand col., *for* “ page 100 ” *read* “ page 101.”
„ 152, line 22 from bottom, *for* “ See page 147 ” *read* “ See page 150.”
„ 172, line 11 from top, *for* “ App. V., p. 31 ” *read* “ App. V., p. 33.”
„ 196, line 5 from bottom, *for* “ 0·00001166 ” *read* “ 0·00005166.”
„ „ lines 16 and 17 from bottom, *for* $\left.\begin{array}{l}\text{“}1\cdot311\\ \text{“}1\cdot417\end{array}\right\}$ ” *read* $\left.\begin{array}{l}\text{“}1\cdot311\\ \text{“}1\cdot411\end{array}\right\}$ ”
„ 197, line 1, left-hand col., *for* “ 1 mm.” *read* “ 1 mgr.”

STANDARDS COMMISSION.

APPENDIX TO FIFTH REPORT.

PAPERS DELIVERED BY THE WARDEN OF THE STANDARDS.

CONTENTS.

Page

APPENDIX I.—On the business of the Standards Department and the duties of its officers;
  1. Preliminary paper, dated 11th January 1867 - - - - 2
  2. Additional paper on the establishment of the Standards Department; dated 10th June 1870 - 4
" II.—Preliminary paper: List of secondary standard weights and measures in the Standards Department of the Board of Trade, with tables of equivalents of the several legal weights and measures, and observations on the question of adding to or of discontinuing any of the number of these secondary legal standards; dated 5th October 1866 - - - - 6
  P.S.—On the legal use, &c. of metric weights and measures, with opinion of Law Officers of the Crown; dated 25th July 1868 - - - 14
" III.—Preliminary paper: Proposed mode of comparison and reverification of official standards of weights and measures; dated 12th October 1866 - - 18
" IV.—Actual comparison of Board of Trade standards of Avoirdupois Weight and Troy Weight; dated 24th April 1867 - 26
" V.—Reverification of official standard Imperial weights, and original verification of new standard Imperial weights:
  1. Reverification of platinum auxiliary standard weights, as the basis for reverifying the official standard bullion weights; principles and practice of comparing standard weights differing in density; dated 29th June 1868 - - - 31
  2. Further reverification of official standard bullion weights and of other official standard weights; dated 2nd January 1869 - 47
  3. Further verification of official standard Imperial weights; dated 8th April 1870 - - - 59
  4. On the standard weights for coins, including construction and verification of new standard weights; dated 21st March 1870 - - 76
" VI.—Part I. Reverification, &c. of official standard Imperial measures of capacity; dated 24th March 1870 - 79
  Part II. Completion of verification of new official measures of capacity; dated 27th July 1870 - - - 91
" VII.—1. Reverification, &c. of official standard yard and other standard Imperial measures of length; dated 24th March 1870 - - - 97

Page

APPENDIX VII.—*cont.*
  2. Completion of verification of new official standards of length; dated 15th July 1870 - - - 106
" VIII.—1. Reverification of gas measuring standards; dated 2nd April 1870 - 127
  2. On the proposed construction and use of standard test gas meters, &c.; dated July 1870 - - 137
" IX.—On the length of the French metre, in relation to the British Imperial standard of length; dated 6th July 1867 - - 148
" X.—Translation of General Baayer's paper on changes in length and co-efficients of expansion of standard measures of length; dated 7th August 1867 - - - 156
" XI.—Account of the verification at Paris of metric standards of length, weight, and capacity, for the Standards Department; dated in November 1869 and September 1870 - - - - - - 159
" XII.—On the verification of the official standard metric weights and measures; dated 28th October 1870 - - - 167
" XIII.—Papers relating to the International Standards Commission at Paris, for the construction and verification of new primary metric standards; dated 1867–1870 - 199
" XIV.—Correspondence and opinion of Law Officers of the Crown, on the legal validity of the official indenture of verification of local standard weights and measures; dated July 1870 - - 208
" XV.—On more uniform normal thermometric temperature and barometric pressure, in the comparison of standard weights and measures; dated 15th July 1870 - 210
" XVI.—Scale of errors to be allowed at the Standards Department in the comparison of imperial standard weights and measures; dated 30th July 1870 - - - 212
" XVII.—Number and denominations of legal secondary standard weights and measures; dated 25th June 1870 - - - 219
" XVIII.—List of standard and other weights and measures deposited in the Standards Department; dated 30th July 1870 - 222
" XIX.—List of balances and other comparing or auxiliary apparatus of the Standards Department; dated 30th July 1870 - 226
" XX.—Verification of new Imperial standard measures of 10 feet and 6 feet; of new standard glass and coin weights; and of standard test gas meters; dated 1870–1 229

APPENDIX TO FIFTH REPORT.

APPENDIX I.

1. PRELIMINARY PAPER DELIVERED by the WARDEN OF THE STANDARDS.—On the BUSINESS of the STANDARD WEIGHTS AND MEASURES DEPARTMENT, and the DUTIES of the OFFICERS.

CONTENTS.

	Page
Memorandum prepared for the Board of Trade on the Duties of the Standard Weights and Measures Department:	
Objects contemplated in establishing the new Department - - - - - - -	2
Qualifications of Chief Officer - - - -	"
General description of the duties of the Department -	"
Proposed establishment - - - -	"
Duties of the several officers:	
Warden of the Standards - - - - -	"
Senior Clerk - - - - -	"
Junior Clerk - - - - -	3
Mechanic, acting as Messenger - - -	"
List of books used in the Department - - - -	3
Official comparisons in aid of scientific researches, or otherwise, now authorized by law - - - - -	"
Question of official comparison of weights and measures for private individuals - - - - - -	"
How affected by fees charged for comparisons by local inspectors - - - - - - -	"
Provision should be made by law for similar fees on comparisons with any additional local Standards - -	"
Suggested regulations on the subject by Board of Trade -	"

Memorandum delivered to the Board of Trade Committee (Mr. Cave and Mr. Hunt) on 31st August 1866.

The nature of the business to be performed in the Standard Weights and Measures Department, under the present system of the office, as well as the duties of the several officers, will be found described in the following memorandum lately prepared for, and delivered to, the Committee for revising the salaries, &c. in the Board of Trade.

Duties of Standard Weights and Measures Department.

Objects contemplated in establishing the new Department.

The provisions of the Standard Weights and Measures Act of the last session which relate to the Standards Department were founded upon the recommendations of the Standards Commission and Committee in their several Reports.

It was considered by them to be an important and material object to strengthen the Government Department of Weights and Measures.

1. By constituting, instead of the existing subordinate Department under the Comptroller-General of the Exchequer, a separate and distinct department, under a chief officer, with a distinctive title and position, and specially responsible for executing its duties.

2. By altering the principle of the business of the Department, and making it an active instead of a merely passive department of the Government; with sufficient authority for maintaining in efficiency all the local standards and supervising their use, and for furnishing instructions to the local officers in order to give force and unity to the exercise of their functions, and for collecting information from them upon the subject of Weights and Measures, to be reported to the Government and to Parliament.

3. By improving the equipments of the Department, furnishing for its use the most accurate and scientific apparatus, more particularly for the comparison and verification of measures of length, instead of the rude apparatus then used in the office, thus enabling the department to be serviceable for the comparison of weights and measures for scientific purposes, in addition to the verification of the local standards required for the testing of weights and measures used in the ordinary transactions of business.

Qualifications of Chief Officer.

In the earlier Reports of the eminently scientific men who formed the several Standards Committees it was recommended that a scientific officer should be placed at the head of the proposed new Department. In their latest Report they stated that it was not so requisite that the chief should be a person of high scientific attainments as that he should be conversant with public business and with the peculiar nature of standard operations, and thus more practically qualified to execute the duties of the office.

General description of the duties of the Department.

The duties of the Standards Department consist generally in the custody of the Imperial standards of length and weight, and of the secondary official standards, and in the maintenance in proper condition of these standards and the apparatus for their use; the comparison and verification of local standards of weights and measures with the official standards, and the preparing and entering in the official books of the necessary documents and correspondence relating to these standards and their comparison and verification; the carrying out of all other operations with reference to standards of weights and measures for scientific researches or otherwise, as the Board of Trade may from time to time authorize or direct; and the execution of such other duties connected with the standards as the officers may be called upon to perform.

Propos Establi ment.

It is proposed that the Department shall be originally constituted with the following officers:—

Chief Officer—Warden of the Standards,
Senior Clerk,
Junior Clerk,
Mechanic, acting also as Messenger.

Duties officers

The special duties of these officers will be as follows:—

Warden of the Standards.

Warde the Sta ards.

He will be charged with and immediately responsible for the custody of the Imperial standards and the secondary official standards and apparatus, and will generally direct, superintend, and be responsible for the due execution of all the duties of the Department by himself and the subordinate officers. He will sign the indentures of verification, and conduct the correspondence of the Department, and will prepare and sign the annual Report to the Board of Trade, to be presented to Parliament, under the provisions of the Standards Act. He will give his special attention to the comparison and verification of primary or principal standards and more particularly to the reverification of the Imperial standards and their principal copies, and of the official standards, as well as of such weights and measures as may be required to be verified for scientific purposes. He will make the necessary arrangements for the meetings of the Standards Commission at the office, and will give such assistance and supply them with such information in his power as may be required. It will be his duty also to furnish such information upon the subject of weights and measures to the Board of Trade as he may be called upon to give, or which he may consider requisite to bring before them. He will keep watch upon the records in the books of the office, with reference to all the local standards which have been verified in the Department, and it will be his duty to call the attention of the several local authorities or officers in the event of the legislative provisions for the periodical reverification of these local standards not being duly complied with, or of their not being in efficient condition when duly sent for reverification.

Senior Clerk.

Senio

It will be the special duty of the Senior Clerk to receive the standard weights and measures sent to the office for comparison and verification, and to see that they are in accordance with the requisition, and that such requisition is in conformity with the established Regulations of the Department. (See A.) He will himself compare and verify

Appendix I.—*continued.*

these several standards with the official standards, or give directions, when necessary, to the Junior Clerk to assist him in the comparison, prepare the indentures of verification, and return the standards to the persons authorized to receive them. He will keep the Register of Verifications, and will report from time to time to the Warden all cases in which standards verified in the office have not been brought back for reverification within the periods prescribed by law. He will prepare the ordinary and formal documents and letters from the office, for the Warden's signature. He will be charged with the conduct of the ordinary business of the Department during the occasional or necessary absence of the Warden, and under the Warden's direction, when he will sign the indentures of verification and other documents for the Warden. And he will undertake all the duties of the Junior Clerk in his absence for vacation, or from illness.

Junior Clerk.

Junior Clerk.

He will enter in the books of the Department all the official documents and correspondence, and will assist the Senior Clerk in the comparison and verification of standard weights and measures, and generally in the business of the Department. He will also be charged with all the duties of the Senior Clerk during his occasional absence from illness, or for his vacation.

Mechanic, acting as Messenger.

Mechanic, acting as Messenger.

It remains only to state the duties of the Mechanic, acting also as Messenger. His duties consist in keeping the standards and apparatus of the Department in good order by cleaning, oiling, and adjusting the metallic parts from time to time. He assists also in the verification of standards by lifting the heavy weights and measures, and placing them in proper positions, and more especially in the comparison of measures of capacity by filling these measures with water, and emptying them. He attends also to the regulation of the temperature of the comparing rooms, and to the adjustment of the mechanical comparing apparatus. His services are also particularly required in keeping the gas standards in good condition, and in preparing the copies of the gas standards for verification, as well as in stamping the verified copies of the standards. He executes all the ordinary duties of messenger of the Department.

(Signed) H. W. Chisholm.

August 31, 1866.

List of books used in the Department.

The list of books used in the Department is as follows:—

Day Book of Verifications.
Register of Verifications of Weights, Measures of Capacity and Length.
Register of Verification of Gas Measures.
Three Books for noting and recording Comparisons, viz.:
  1. Comparisons of Measures of Length.
  2. „ of Weights and Measures of Capacity.
  3. „ Gas Measures.
Correspondence Book.
Minute Book.
Register Book for Letters.
Counterparts of Indentures, bound in a book.
Magistrates' Authorities and Makers' Requisitions, pasted in a guard-book.
Total, 11 books.

Proposed extended duties of the Department in relation to the Local Inspectors.

In order to carry out the several recommendations which have been made for reconstituting the Standards Department with greater authority and more extended duties, and thus adding to its efficiency by making it a more active Department, in relation generally to the weights and measures of the kingdom, it has to be considered how far the duties and authority of the Standards Department should extend to the obtaining information from the local officers, for record in the Department, respecting the local standards, and weights and measures in common use, and the mode in which the duties of the Inspectors are performed, but also to the inspection of these local standards, and the apparatus connected with them, as well as to the furnishing detailed instructions to the Local Inspectors, under the authority of the Board of Trade, with the view of securing unity of action in the proper execution of their duties, without undue interference with the authority over these local officers, now vested by law in, and exercised by, the Local Magistracy.

The preliminary information which appears to be required for entering upon the consideration of these points, will be found in the Paper upon the Relation of the Standards Department to the Local Authorities and Local Inspectors of weights and measures (App. 1 to Fourth Report).

Official comparisons in aid of scientific researches, or otherwise, now authorized by law.

In section 11 of the Standards Act of last session, a provision is contained, "that it shall be the duty of the "Warden of the Standards to conduct all such comparisons, verifications, and other operations with reference "to standards of length, weight, or capacity, in aid of "scientific researches, or otherwise, as the Board of Trade "from time to time authorize or direct."

It may be desirable that some consideration be given to the question of the mode in which this provision should be carried out, and how far it may be expedient that the Board of Trade should exercise this unlimited authority thus conferred upon them, to direct any comparisons to be made in the Department with the official standards that they may think proper; whether, in fact, and if so, under what Regulations they should authorize weights and measures to be compared for private individuals, or for engineering or manufacturing firms who may require to use weights and measures of extreme accuracy.

Question of official comparison of weights and measures for private individuals, &c.

It will remain for the Board of Trade to determine if such last-mentioned additional duties should be imposed upon the Department, and thus to give the public the benefit of having their weights and measures compared and verified with the official standards by means of the very elaborate apparatus of the Standards Department, with the further advantage of having the exact difference from the standards, within the limits tolerated, noted in the official indenture of verification. But care should be taken not to overload the Department with business, which is especially the duty of the local officers to perform.

How affected by fees charged for comparisons by Local Inspectors.

It must also be remembered that under section 9 of the Standards Act, no fee is to be payable on the verification of any standard, or any stamp duty on the indenture of verification. Certain fees are, however, imposed by law on the comparison and stamping by the Local Inspectors of weights and measures in common use.

A Table of these fees is appended to the Act 5 & 6 Wm. 4. cap. 63., and is as follows:—

—	Brass Weights.	Iron. Weights.
Weights—	*s. d.*	*s. d.*
Each half-hundred weight - - - -	0 9	0 3
„ quarter „ - - - -	0 6	0 2
„ stone „ - - - -	0 4	0 1
„ weight under a stone, to 1 lb. inclusive.	0 1	0 0½
„ weight under 1 lb. - - - -	0 0½	0 0½
„ set of 1 lb. and under - - -	0 2	0 2
Wooden dry measures—		
Each bushel - - - - - - - -	—	0 3
„ half-bushel - - - - - - -	—	0 2
„ peck and all under - - - -	—	0 1
„ yard - - - - - - -	—	0 0½
Liquid measures of metal—		
Each 5-gallon - - - - - - -	—	1 0
„ 4 „ - - - - - - -	—	0 9
„ 3 „ - - - - - - -	—	0 6
„ 2 „ - - - - - - -	—	0 4
„ 1 „ - - - - - - -	—	0 2
„ ½ „ - - - - - - -	—	0 1
„ quart and under - - - -	—	0 0½

Provision should be made by law for similar fees on comparisons with any additional local standards.

With reference to these fees so fixed by statute, and made payable by Inspectors of weights and measures, it should be particularly noticed that it will be necessary, in the event of any addition being made to the number of standards, and particularly of other measures of length, that the corresponding weights and measures in common use will necessarily require to be compared and stamped by the Local Inspectors; and a similar provision should, therefore, also be made by law for the fees to be charged by the Local Inspectors.

Suggested Regulations by Board of Trade.

It may be suggested, with respect to all comparisons with the official standards, *in aid of scientific researches,* that in each case a special application should be made either to the Board of Trade, or to the Warden of the Standards. For carrying out such comparisons, as well as all other comparisons of weights and measures with the official standards, that may be requested by private individuals or others, it will probably be found expedient that regulations should be framed and issued by the Board of Trade; and it will have to be determined in all such cases, whether any and what fee should be chargeable and payable for obtaining the more authoritative comparison with the official standards, and the indenture of verification from the Standards Department.

Standards Department, H. W. CHISHOLM,
January 11, 1867. Warden.

Appendix I.—*continued.*

2. ADDITIONAL PAPER DELIVERED by the WARDEN OF THE STANDARDS.—On the DUTIES, &c. OF THE OFFICERS OF THE STANDARDS DEPARTMENT.

CONTENTS.

Page
Duties of officers of the Standards Department, as originally described - - - - - - - 4
Existing officers and duties. Establishment in June 1870
  Provisional appointment of Mr. Chisholm - - „
  And of Mr. Chaney - - - - - „
  Other clerks - - - - - - - „
  Duties of the officers: Warden of the Standards - - „
  Duties of the officers: Mr. Chaney - - - „
  Duties of the officers: Of the officers generally - - „
  Departmental Minute as to official books and duties, 12 Oct. 1869 - - - - - „
Amount of business performed, 1866–1870 - - 5
Reference to studies of scientific works - - - „
Future business of the Department - - - „
Future Establishment: Warden of the Standards. Mr. Chisholm's personal position - - - „
Future Establishment: Mr. Chaney's official status - - „
Future Establishment: Other officers - - - - „
Future Establishment: Inspection of Standards - - - „
Future Establishment: Messengers, &c. - - - - „
Enclosure A.—Copy of Treasury letter, dated 26th Sept. 1867 - - - - - „

Duties of Officers of Standards Department as originally described.

The duties to be performed in the Standards Department by the several officers, as originally proposed upon the constitution of the Department, have been described in the preceding Paper which was laid before the Standards Commission upon its appointment, as a preliminary paper. The following further information may now be given after more than three years' experience of the working of the business of the Department.

Existing officers and duties. Establishment in June 1870.

First, as regards the existing officers and duties. The present establishment of the Standards Department is as follows:—

Office.	Name of Officer.	Annual Salary.			
		Minimum.	Annual Increase.	Maximum.	In June 1870.
		£	£	£	£
Warden of the Standards.	H. W. Chisholm	—	—	—	900
Clerks - -	H. J. Chaney -	—	—	—	300
	H. Newport -	100	15	300	140
	A. H. Maude -				110
Temporary Clerk -	G. Mudge -	—	—	—	91 (=35*s.* a week.)
Office Keeper and Mechanic.	D. Porter -	80	5	100	100
Temporary Messenger (Commission).	J. Picton - -	—	—	—	78 (=30*s.* a week.)
Temporary Assistant to the Mechanic.	B. Jones - -	—	—	—	65 (=25*s.* a week.)

Provisional appointment of Mr. Chisholm, No. 47 of 1867. See (A.) p. 5.

It may be seen from the Parliamentary Return of 1867, relating to the establishment of the Board of Trade, copies of which have been laid before the Commission (*see* pp. 8 and 17), that my appointment as Warden of the Standards is at the present time merely provisional; and by the appended copy of the Treasury letter of 26th September 1867, that the provisional salary of 900*l.* a year has been awarded me until the Standards Commission should report what should, in their opinion, be the staff and salaries assigned to the officers of the Standards Departments, when "My Lords will be prepared to take the question of "Mr. Chisholm's salary again into consideration."

And of Mr. Chaney.

The position of Mr. Chaney is in like manner provisional, as regards both his official status and salary.

Other clerks.

Mr. Newport and Mr. Maude, though attached to this Department, are appointed officers of the Board of Trade as second-class or junior clerks, and they receive the salary of that class, as specified above.

Duties of the officers. Warden of the Standards.

In addition to the duties of the Warden of the Standards, as previously described upon the original constitution of the office, a large portion of my time and attention has been given to the several subjects brought by me before the Standards Commission, which have also involved much correspondence both at home and abroad. It has formed part of my duty to watch and report the course of legislation, as well as all legislative proceedings relating to weights and measures both in this and in foreign countries, and the colonies, including India.

At page 17 of the Parliamentary Paper of 1867, before referred to, reference is made to the financial business upon which I was employed for the Treasury. This work is now very nearly completed, but it has been of an exceedingly arduous description. During the period of nearly four years since the establishment of the Standards Department, it has been only by incessant application, both in office hours and early and late at my own house, and also when absent from home during my so-called vacation, that I have been enabled to execute the departmental and financial work which has continually pressed upon me.

Mr. Chaney.

Much of the work assigned to Mr. Chaney in the Memorandum of 11th January 1867 has been necessarily transferred to the other clerks, in consequence of the increase of the business of the Department, and especially from Mr. Chaney's time having been occupied in assisting the Warden in the work of the Commission, and in the preparation of the several Papers laid before them. With this object Mr. Chaney has undertaken a great portion of the numerous comparisons required for the reverification of the official Standards hitherto used in the Department, and for the original verification of the more recently constituted Standards.

Of the officers generally.

The existing books of record of the verifications of the Department, as well as the duties of the clerks in relation to these verifications, which constitute the principal business of the office, are described in the following Minute:—

Departmental Minute of 12th Octo

12th October 1869.

The Warden directs that the following books of record of verifications be now kept and used in this Department, viz.:

1. A Day Book, in which will be entered every day the particulars of all Standards received here for comparison.
2. The Register, established in 1825, and since used as a record of all local Standards verified and reverified.
3. The Register of Troy Bullion Standards, established in 1856.
4. The Register of Gas Measuring Standards, established in 1861.
5. The Account of Standards Rejected, established in 1868.
6. The Monthly Account of Standards Compared in this Department, established in 1868.

At present a Waste Book is also used, which contains an entry of each set of Standards delivered for verification, stating the number of the indenture (also marked upon the Standards), the description of Standards, the date of delivery, the district of inspection, and the name of the agent.

For the Waste Book will now be substituted the Day Book, to contain the same information in a tabular and more regular form, with the addition of an alphabetical index of districts of inspection, and a numerical index of the numbers of the Standards.

The object of establishing the Verification Book, which is also at present in use, as stated in the Minute of 28th July 1864, was to record the verification of each Standard identified by being stamped with a progressive number, corresponding with the number of the indenture. This object will be carried out in the Day Book, which will contain a column for the number of the indenture and of the Standards, the numerical index hitherto attached to the Verification Book, and which has been found of much use in the identification of each of the local Standards, being also attached to the Day Book. A column for remarks in the Verification Book was found useful in giving the particulars of Standards rejected; but it was subsequently found necessary that the particulars of rejected Standards should be recorded in a more regular form, and the Warden of the Standards accordingly directed a book of "Standards Rejected" to be prepared, which has been kept since 14th February 1868.

The Register of Verification is kept upon the system which was established in 1824, and refers only to the Imperial Weights and Measures under 5 Geo. 4. c. 74. There is a separate register of Troy Bullion Standards and a third register of Gas Measuring Standards.

As all the objects intended by the establishment of the Verification Book will now be accomplished by the entries in the Day Book, the Register of Verifications, and the Rejected Standards Book; and as the Verification Book established in 1864 is now filled up with entries, it appears now to be expedient to discontinue the Verification Book as a separate book of the Department.

To ensure accuracy in recording the local Standards, the Warden directs that it be the duty of the Junior Second Class Clerk to enter in the Day Book all the necessary particulars from the indentures and the accompanying requisitions; and he will be careful in those cases where the Standards have not been previously stamped with the number of the indenture to record the number on the Standards, and to assign the proper number from the indenture.

He will be charged with the duty of entering all particulars in the numerical and alphabetical index of the Day Book. The book of "Standards Rejected," the "Monthly

Account of Standards Compared," will also be kept by the Junior Second Class Clerk.

The Senior Second Class Clerk will enter in the "Register of Verification," from the indentures, the particulars of all local Standards verified and reverified. He will keep the register of Gas Measuring Standards and the register of Troy Bullion Standards, and he will also examine the indentures prepared by the Temporary Clerk before submitting them for signature.

It will be the duty of the Senior Clerk at the end of each month to compare the entries in the register with the indentures and with the requisitions signed by the agents or local authorities. He will also examine the correctness of the indices in the Day Book.

Upon the legalization of any further Imperial Standards, or of Metric Standards, and upon any re-arrangement of the districts of inspection of Weights and Measures, it will become necessary to re-consider the mode of keeping the official books, and it will probably be found desirable to establish a ledger, showing under the head of each district a reference to all transactions with the Standards Department.

H. W. Chisholm.

Amount of business performed, 1866-1870.

The amount of business actually performed in the Department since its original constitution in August 1866 may be seen from the official statements contained in the four Annual Reports of the Warden of the Standards, which have been laid before Parliament and before the Commission. Its progressive increase may also be inferred from the large additions made to the number of Standards, and to the Departmental apparatus, and may be shown by the entries in the correspondence books.

Reference to studies of scientific works.

Reference may also be here made to the number of scientific and other works in English, French, German, &c., relating to, or connected with, Standards, which have been procured for Departmental use, and added to the Library. The careful study of many of these works has been found absolutely indispensable to the proper discharge of the duties now thrown upon the Department.

Future business of the Department.

So far as relates to the future business of the Department it must unquestionably be largely increased, and at the same time a corresponding addition must accrue to the personal labours and responsibility of the Chief of the Department, in the event of the recommendations of the Commission for the improvements in our system of weights and measures being carried into effect. It may be sufficient here briefly to recite the heads of the new business which will fall upon the Department:—

1. The addition of metric weights and measures to those of the Imperial system.
2. Scientific and other verifications for manufacturing and chemical purposes, and for the general public.
3. Duties connected with the Standard coin weights, including their verification.
4. The control over the system of local verification and inspection throughout the country, including the preparation of official instruction.
5. The collection and arrangement of periodical returns from verifiers and inspectors.

Future establishment. Warden of the Standards.

As to the future and more permanent establishment of the Standards Department, it may deserve consideration whether the Department should not be constituted as a separate Department of the Board of Trade, and its Chief Officer put upon a par, as regards position and salary, with the Chief Officers of the other Departments of the Board of Trade.

Mr. Chisholm's personal position.

It may also be thought worthy of consideration whether, after a public service exceeding 45 years, and my former responsible duties of Chief Clerk of the Exchequer, together with the labours and responsibility incurred in organizing the Standards Department and its business, a special additional allowance beyond the permanently fixed salary of the Warden of the Standards, should not fairly be awarded to me. It should be noticed that important duties will devolve upon me, probably throughout the next two years, as one of the delegates to the Paris Conference for the construction and verification of new metric Standards for International purposes. During my stay at Paris, all official matters of any importance will be submitted to me, to be dealt with in the same way as they have hitherto been, during absence from London either on service or on vacation.

Mr. Chaney's official status.

The time has now arrived when I feel it my duty strongly to recommend that Mr. Chaney's official position should be determined by appointing him Senior Clerk in the Standards Department, a position which he has well deserved from his official conduct and services. This appears also to be now the more requisite, in order that he may be in a position of authority to act in my absence as the Chief Officer of the Department. In this case not less salary according to the Board of Trade scale for a Senior Clerk may be awarded to him.

Other officers.

With respect to the other officers of the Department, it may be sufficient that as the duties of the office are found to increase, it may be left to the Chief of the Department to represent the circumstances to the Board of Trade, with the view to the appointment of additional clerks, either junior or temporary, from time to time.

Inspection of Standards.

No. 72, 1870.

The question of the appointment of Inspectors of Standards and their salaries, &c., as recommended by the Commission in their Fourth Report, may be left for future consideration, in the event of this recommendation being adopted by the Government and the Legislature. As to these appointments, reference may be made to a recent Parliamentary Return, which shows the number of existing Inspectors attached to the several Public Departments, their salaries, &c., which has been laid by me before the Commission.

Messengers, &c.

In conclusion, I may state that David Porter's time is fully occupied in his duties of Office Keeper and Mechanic, and that he requires the constant services of an assistant in his mechanical duties and in looking after the Departmental apparatus. This duty is now discharged by B. Jones, who is only temporarily engaged. The services of two other persons are also needed as messengers. We find even at the present time that when Picton is sent out, which frequently occurs, either Porter or Jones must be taken from their work in keeping the apparatus in order, or in preparing and arranging the local standards for verification, to attend to persons coming to the office on official business, or upon the Officers of the Department. I should recommend that Picton be appointed more permanently as Messenger in the Department, and the immediate appointment of another messenger is also urgently required.

H. W. Chisholm,
Warden of the Standards.

Standards Department,
10th June 1870.

Enclosure A.

The Secretary of the Treasury to the Secretary of the Board of Trade.

Sir, Treasury Chambers, 26th Sept. 1867.

With reference to the paragraph in your letter of 21st December last, which relates to the position of Mr. Chisholm as Warden of the Standards, I am desired by the Lords Commissioners of Her Majesty's Treasury to state, for the information of the Lords of the Committee of Privy Council for Trade, that although my Lords anticipate that the Commissioners at present engaged in inquiring into the condition of the Standards of Weights and Measures will in their Report recommend what should eventually be the staff and salaries assigned to the officers of the Standards Department, they are of opinion that a provisional arrangement should be made respecting Mr. Chisholm's salary pending the Report of the Commission.

That gentleman's salary as Chief Clerk of the late Exchequer Office at the time of his transfer to the Board of Trade was 700*l.* a year, and this amount it was intended he should retain under any circumstances until some permanent arrangement should be made with regard to the Wardenship of the Standards.

My Lords are of opinion that, looking at the labour and responsibility which will devolve upon Mr. Chisholm in connexion with the inquiry entrusted to the Commission of which he is a member, and of which the chief burden of the work will fall upon him, an addition should be made to the salary of 700*l.* which he enjoys.

This addition my Lords are pleased to fix at 200*l.* a year, making his total emoluments equivalent to a salary of 900*l.* a year so long as he shall serve upon the above-named Commission.

Having regard to Mr. Chisholm's length of service and to the useful and zealous assistance he has afforded to this Board in matters unconnected with the ordinary duties of his office, their appreciation of which my Lords are glad to have this opportunity of putting on record, and also to the fact that Mr. Chisholm commenced his duties under the Board of Trade from the date of the passing of the Standards of Weights and Measures and Coinage Act, 1866, which transferred the Standards to the custody of that Department, although continuing to hold the appointment of Chief Clerk of the Exchequer until its abolition on 31st March last, my Lords consider that his special allowance may properly be made payable to him from the date of the passing of the Act, 6th August 1866.

When the Report of the Commission has been communicated to this Board, my Lords will be prepared to take the question of Mr. Chisholm's salary again into consideration.

I am, &c.
Geo. A. Hamilton.

The Secretary,
Board of Trade.

APPENDIX II.

PRELIMINARY PAPER DELIVERED by the WARDEN OF THE STANDARDS.—LIST OF STANDARDS; PROPOSED ADDITIONS, &c.

CONTENTS.

Page
List of Board of Trade Standards - - - 6
Tables of Equivalents: Weights—Avoirdupois - - 7
„ „ Troy - - - „
„ „ Bullion - - „
„ Measures—Of Length - - 8
„ „ Of Capacity - - „
Description of Board of Trade Standards - - - „
Other more primary Standards deposited at the office - „
Other Imperial Weights and Measures, ditto - - „
Gilt gun metal Kilogram - - - - - „
Construction of Standard subdivided Yard and Metre - „
Apothecaries' Weight, discontinuance of - - - „
Pharmaceutical Weights and Measures established by law 9
Tables of ditto, with equivalents - - - - „
Proposed additions to, or discontinuance of, Board of Trade Standards:
  Avoirdupois Weights:
    Decimal scale of multiples, and parts of Avoirdupois pound - - - - - - - „
    Question of Standard 3½ lb. weight - - „
    10 lb. Standard weight - - - - „
    Decimal Grain Standard weights recommended - „
  Troy Weights; contemplated abolition of Troy scale 10
    Considerations why discontinuance of Troy Weights inexpedient at the present time - - - „
    Except the Troy pound, to be discontinued as practically useless - - - - „
  Gold Coin Weights, suggested Standards of - „
    Proposed scale and equivalents - - - „
  Measures of Capacity; proposed Standard wine bottle and half wine bottle - „
  „ and fluid ounce, Standard weights „
  Measures of Length; proposed new Standards, including subdivisions of the yard - - - „
  Summary of proposed additions, &c. to Standards - 11

Page
Metric Weights and Measures, information respecting proposed:
  In Report of Committee on Weights and Measures, 1862 - - - - - - - 11
  Bill of 1864 to establish Metric Standards, &c. - „
  Probable number of additional Standards proposed by the Bill - - - - - - - „
  Opposed by Government; provisions of amended Bill and of Metric Act, 1864 - - - - - „
  Clause for establishing Metric Standards, proposed in Standards Bill, 1866 - - - - - „
  Conclusive objections against insertion of the proposed clause - - - - - - - 12
  Notice of motion in session 1867 upon the subject - „
  Rests with Commission whether or not to express any opinion - - - - - - - „
  Suggested deposit in the Department, of verified Litre, the unit of metric capacity - - - „
Postscript:
  Cases involving legal construction of Metric Act - „
    (1.) Legality of use of Metric Weights, &c. in shops - - - - - - „
      Case submitted to law officers of the Crown - 14
      Their opinion - - - - - - „
    (2.) Legality of officially verifying Metric Weights and Measures, and of charging Fee - -

(A.)—List of Standards proposed to be transferred to the Standards Department by the Astronomer Royal 15
(B.)—Copy of Metric Bill, 1864, with schedule of Metric Weights and Measures, and their equivalents - 16
(C.)—Copy of the Metric Act - - - - 17
(D.)—The Right Hon. T. Milner Gibson to Mr. Chisholm, 15th June 1866 - - - - - „

LIST of the SECONDARY LEGAL STANDARD WEIGHTS and MEASURES in the Standards Department of the Board of Trade; with Tables of Equivalents of the several Legal Weights and Measures; and observations on the questions of adding to, or discontinuing any of, the number of these Secondary Legal Standards.

List of Board of Trade standards.

There are seventy-seven secondary legal standards of Imperial weights and measures now in use in the Standards Department of the Board of Trade, as may be seen from the following list:—

A LIST of the Standards now in use in the Standards Department of the Board of Trade.

Weights.			Measures. 5 Geo. 4. c. 74.		Gas Standards. 22 & 23 Vict. c. 66.	
5 Geo. 4. c. 74.		16 Vict. c. 29.	Of Extension.	Of Capacity.	Weight.	Measures.
Avoirdupois.	Troy.	Troy for Bullion.				
56 lbs.	1 lb.	500 oz.	Yard.	Bushel.	62·321 lbs., weight of cubic foot of distilled water at 62°.	Cubic foot bottle.
28 „	6 oz.	400 „		½ bushel.		10 feet gas-holder.
14 „	3 „	300 „		Peck.		5 feet ditto.
7 „	2 „	200 „		Gallon.		1 foot ditto.
4 „	1 „	100 „		½ gallon.		
2 „	10 dwts.	50 „		Quart.		
1 „	5 „	40 „		Pint.		
8 oz.	3 „	30 „		½ pint.		
4 „	2 „	20 „		Gill.		
2 „	1 „	10 „		½ gill.		
1 „	12 grains.	5 „				
8 drams.	6 „	4 „				
4 „	3 „	3 „				
2 „	2 „	2 „				
1 „	1 „	1 „				
½ „		0·5 „				
		0·4 „				
		0·3 „				
		0·2 „				
		0·1 „				
		0·05 „				
		0·04 „				
		0·03 „				
		0·02 „				
		0·01 „				
		0·005 „				
		0·004 „				
		0·003 „				
		0·002 „				
		0·001 „				
16	15	30	1	10	1	4

Total Number of Standards, 77.*

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* There is also a 10 lb. standard weight, deposited at the Exchequer by Captain Kater in 1825 (see page 6), and used for the verification of the standard gallon, the unit of capacity. But the 10 lb. standard weight has never been used for the comparison and verification of other 10 lb. weights; nor is a 10 lb. weight comprised in a set of avoirdupois local standard weights, verified for the use of local inspectors of weights and measures.

Appendix II.—*continued.*

Tables of equivalents.

The following Tables show the equivalents of the legal secondary standards of weights and measures now in use in the Standards Department of the Board of Trade:—

WEIGHTS.

Avoirdupois weights.

Avoirdupois Weight.

	lb.	oz.	dr.	gr.
	56	—	—	= 392,000
	28	—	—	= 196,000
	14	—	—	= 98,000
	7	—	—	= 49,000
	4	—	—	= 28,000
	2	—	—	= 14,000
$1\frac{1240}{5760}$ or 1·215277 &c. lb. Troy =	1	= 16	= 256	= 7,000
	$\frac{1}{2}$ or 0·5	= 8	= 128	= 3,500
	$\frac{1}{4}$ or 0·25	= 4	= 64	= 1,750
	$\frac{1}{8}$ or 0·125	= 2	= 32	= 875
	$\frac{1}{16}$ or 0·0625	= 1	= 16	= $437\frac{1}{2}$ or 437·5
		$\frac{1}{2}$ or 0·5	= 8	= $218\frac{3}{4}$ or 218·75
		$\frac{1}{4}$ or 0·25	= 4	= $109\frac{3}{8}$ or 109·375
		$\frac{1}{8}$ or 0·125	= 2	= $54\frac{11}{16}$ or 54·6875
		$\frac{1}{16}$ or 0·0625	= 1	= $27\frac{11}{32}$ or 27·09375
		$\frac{1}{32}$ or 0·03125	= $\frac{1}{2}$	= $13\frac{43}{64}$ or 13·546875

Troy Weight.

Troy weights.

	lb.	oz.	dwt.	gr.
$\frac{5760}{7000}$ or 0·822857 &c. lb. Avoird. =	1	= 12	= 240	= 5760
	$\frac{1}{2}$ or 0·5	= 6	= 120	= 2880
	$\frac{1}{4}$ or 0·25	= 3	= 60	= 1440
	$\frac{1}{6}$ or 0·166	= 2	= 40	= 960
	$\frac{1}{12}$ or 0·083	= 1	= 20	= 480
		$\frac{1}{2}$ or 0·5	= 10	= 240
		$\frac{1}{4}$ or 0·25	= 5	= 120
		$\frac{3}{20}$ or 0·15	= 3	= 72
		$\frac{1}{10}$ or 0·1	= 2	= 48
		$\frac{1}{20}$ or 0·05	= 1	= 24
			$\frac{1}{2}$ or 0·5	= 12
			$\frac{1}{4}$ or 0·25	= 6
			$\frac{1}{8}$ or 0·125	= 3
			$\frac{1}{12}$ or 0·0833	= 2
			$\frac{1}{24}$ or 0·0416	= 1

Bullion Weight.

Bullion weights.

	Troy lb.	Decimal Troy oz.	gr.
$34\frac{2}{7}$ or 34 ·285714 &c. lb. Avoird. =	$41\frac{2}{3}$ or 41·666	= 500	= 240,000
	$29\frac{1}{3}$ or 29·333	= 400	= 192,000
	25	= 300	= 144,000
	$16\frac{2}{3}$ or 16·666	= 200	= 96,000
$6\frac{6}{7}$ or 6·857142 &c. ,, =	$8\frac{1}{3}$ or 8·333	= 100	= 48,000
	$4\frac{1}{6}$ or 4·166	= 50	= 24,000
	$3\frac{1}{3}$ or 3·333	= 40	= 19,200
	$2\frac{1}{2}$ or 2·500	= 30	= 14,400
	$1\frac{2}{3}$ or 1·666	= 20	= 9,600
$\frac{48}{70}$ or 0·685714 &c. ,, =	$\frac{5}{6}$ or 0·833	= 10	= 4,800
	$\frac{5}{12}$ or 0·416	= 5	= 2,400
	$\frac{1}{3}$ or 0·333	= 4	= 1,920
	$\frac{1}{4}$ or 0·250	= 3	= 1,440
	$\frac{1}{6}$ or 0·166	= 2	= 960
$\frac{175}{192}$ or 0·911458 &c. oz. Avoird. =	$\frac{1}{12}$ or 0·083	= 1	= 480
		0·5	= 240
		0·4	= 192
		0·3	= 144
		0·2	= 96
		0·1	= 48
		0·05	= 24
		0·04	= 19·2
		0·03	= 14·4
		0·025*	= 12
		0·02	= 9·6
		0·01	= 4·8
		0·005	= 2·4
		0·004	= 1·92
		0·003	= 1·44
		0·002	= 0·96
		0·001	= 0·48

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* The 0·025 oz. weight is not included in an ordinary set of copies Bullion Standards verified in the Department.

Appendix II.—*continued.*

Measures

Of Length.

MEASURES.

Of Length.

1 yard.

Of Capacity.

Of Capacity.

Bushl.	Pecks.	Gallons.	Quarts.	Pints.	Gills.	lb. Avoird. of distilled water weighed in air at 62° Fahr., barom. = 30in.	Cubic inches.
1	4	8	32	64	256	80	2218·192
½	2	4	16	32	128	40	1109·096
	1	2	8	16	64	20	554·548
		1	4	8	32	10	277·274
		½ or 0·5	2	4	16	5	138·637
		¼ or 0·25	1	2	8	2½	69·3185
		⅛ or 0·125		1	4	1¼	34·65925
		$\frac{1}{16}$ or 0·0625		½	2	10 oz.	17·329625
		$\frac{1}{32}$ or 0·03125			1	5 oz.	8·6648125
		$\frac{1}{64}$ or 0·015625			½	2½ oz.	4·33240625

Description of Board of Trade standards.

The standard avoirdupois weights, and troy weights, down to 0·01 oz., are all made of brass. The bullion weights are of gun metal, gilt, except the smaller bullion weights from 0·005 to ·001 oz., which are of platinum wire. There are duplicates or counterpoises of all these weights made of similar metal, the counterpoises of the bullion standards not being gilt.

The standard yard consists of a brass bed with upright steel terminations, with which is a brass rod with wooden handles, to take the measure of the bed. All the local standard yards used in this kingdom and in the colonies, for the comparison and verification of yard measures in ordinary use, are copies of this standard yard bed and rod, and have no subdivisions into feet and inches.

The standard measures of capacity are cylindrical, and made of gun metal, in the following proportions:—

576 parts of copper,
59 „ tin,
48 „ brass,

according to Captain Kater's statement; but he does not mention of what the brass is composed.

Other more primary standards deposited at the office.

The above description applies to the Board of Trade standards, ordinarily used for the comparison and verification of local standards. There are other standards of a more primary character deposited at the office, in addition to the imperial standards of weight and length, the standard pound, and standard yard. A troy pound, which has been only once used for comparison, a gallon, quart, and pint, of conical shape, and a bushel, with projecting hoops, were deposited at the Exchequer by Captain Kater, on 5th August 1825. The following standards were deposited at the Treasury by Captain Kater in 1825, and were removed to the Exchequer on 1st August 1865:—

An avoirdupois lb., No. 1.
An imperial gallon, No. 3.
A quart.
A pint.
4 standard yards with gold points.

All these standards were most accurately verified by Captain Kater, and with the exception of the troy pound, as above stated, they have never been used.

There are several copies of the restored standard yard and pound deposited in this Department, but they have never been used for verifying the local standards made in this kingdom.

There is also another standard 10 lb. weight for verifying an imperial gallon, which was deposited at the Exchequer by Professor Miller in 1855, and was verified by him in relation to the restored imperial standard pound. This standard has never been used for the verification of other 10 lb. weights.

Other imperial weights and measures deposited at the office.

In addition to these Board of Trade legal secondary standards, and other more primary standards, the following weights and measures are deposited at this office:—*

A small box containing the following decimal grain weights, constructed by Messrs. Ladd and Oertling in 1855 under the directions of the Comptroller General of the Exchequer:—

gr.	gr.	gr.	gr.	gr.
1,000				
600	60	6	0·6	0·06
300	30	3	0·3	0·03
200	20	2	0·2	0·02
100	10	1	0·1	0·01

A set of nine troy weights, from 1 lb. to 30 lbs., which were constructed in 1845 for the special purpose of being used by the jury of Goldsmiths at the trial of the pyx, but which have never been actually so used. The bullion standards would now be more properly used, if it were made imperative on the jury to use the official standard weights at the trial of the pyx.

Besides the several before-mentioned copies of the restored standard yard, comprising both line and end standards, the following standard measures of length, being in terms of the restored standard, were deposited at the Exchequer by the Astronomer Royal on 26th June 1857:—

A 12-inch end standard of gun metal, No. 76.
A 6-inch ditto ditto No. 79.
A 3-inch ditto ditto No. 81.
A 3-feet line scale of brass, divided into nails; 1 foot divided into ⅛ths of an inch; 1 foot into $\frac{1}{10}$ths of an inch; and 1 foot into $\frac{1}{100}$ths of a foot.

The defining lines of this 3-feet brass scale are too coarsely cut to admit of its being used as a line standard in any comparisons by means of the new comparing apparatus and microscopes.

Gilt gun-metal kilogram.

There is only one metric standard in the Department, a kilogram of gilt gun metal, constructed by Messrs. Ladd and Oertling, and accurately verified by Professor Miller.

Construction of standard subdivided yard and metre. See Appendix III.p.

At a meeting at the Exchequer on 15th June 1866, of some of the members of the late Standards Committee, they approved of a new standard measure of length being furnished to this Department, consisting of a line standard yard, divided into a half yard and feet, having one foot subdivided into inches, one foot further subdivided into tenths and hundredths, another into half quarters, eighths and sixteenths, and a third inch into thirds and twelfths; and that the exact measure of a metre, a half metre, and tenths of a metre, should also be marked upon the same bar.

It was pointed out to the Committee that a standard subdivided inch was required immediately, in order to ascertain the value of a division of each of the two micrometer screws of the new comparing apparatus for measures of length. A subdivided inch with the tenths marked, and one-tenth divided into hundredths, was accordingly furnished by Messrs. Troughton and Simms, on 17th September 1866. The lines are very finely cut upon a slip of silver, let into a small bar of gun metal about two inches in length.

Apothecaries weight, d continua of.

There has never been any series of legal secondary standards of the old apothecaries weight, now discontinued by authority under the powers granted to the Medical Council by the "Medical Act, 21 & 22 Vict. cap. 90.," passed in 1858. That is to say, there are no distinctive standards for weights used by apothecaries; and although their ounce and grain are to be found amongst the troy weights, there never has been an Exchequer standard for

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* See also appended List of Standards and Apparatus proposed to be transferred to this department by the Astronomer Royal (A.).

Appendix II.—*continued.*

the apothecaries' scruple and drachm, nor do these weights appear to have been ever directly authorized by law.

The following extracts from the "British Pharmacopœia" of 1864* will show the mode in which the Medical Council have exercised their powers of regulating the weights and measures to be used for pharmacy, both in Great Britain and in Ireland:—

Pharmaceutical weights and measures established.

"Under any circumstances it would have been necessary, on this occasion, to revise the pharmaceutical weights and measures of the kingdom. But change became imperative for one division or other of the country, as the Dublin College of Physicians, in their last 'Pharmacopœia,' had led the way by adopting for the first time in pharmacy, the Imperial weights for the ounce and higher denominations —a departure from long-established usage which appeared to the Council judicious and worthy of imitation.

"The three Colleges had long agreed in adopting the Imperial measures for every denomination above the fluid ounce. For the latter denomination a convenient subdivision had been also based on the old pharmaceutical principle that each fluid ounce shall consist of eight parts, called fluid drachms, and each of these of sixty parts called minims. It was impossible to improve that now familiar division.

"The Council in resolving to adopt for pharmacy the Imperial ounce and pound, could not assimilate the subdivision of the ounce to that of the fluid ounce without substituting a new medical grain for the troy grain, hitherto the medical as well as the standard grain of the kingdom. This alteration they did not think advisable. It has therefore appeared to them a necessary consequence that the drachm and the scruple, the old denomination of weight between the ounce and grain of pharmacy, must be abandoned, since they can no longer exist as both simple multiples of the latter, and integral parts of the former. Accordingly all who dispense medicines are recommended to discontinue henceforth the use of the drachm and scruple.

"The weights and measures of the 'British Pharmaco-'pœia,' with their symbols, will now stand as follows:—

Tables of Pharmaceutical weights and measures, with equivalents.

PHARMACEUTICAL WEIGHTS AND MEASURES.

"*Weights.*

"1 pound	lb.	equal to	16 ounces	equal to	7,000 grains.
1 ounce	oz.	-	-	„	437·5 „
1 grain	gr.	-	-	„	1 grain.

"*Measures.*

"1 gallon	C	-	equal to	8 pints.
1 pint	O	-	„	20 fluid ounces.
1 fluid ounce	fl. oz.	-	„	8 fluid drachms.
1 fluid drachm	fl. dr.	-	„	60 minims.
1 minim	min.	-	„	1 minim.

"Temperature in all cases to be determined by Fahrenheit's thermometer, and the specific gravity of liquids is to be taken at the temperature of 60°. All liquids are ordered by measures, unless it is stated otherwise.

"*Relation of Measures to Weights of the British Pharmacopœia.*

1 gallon	equal to the measure of	10	pounds of water.
1 pint	„	1·25	„
1 fluid ounce	„	1	ounce of water.
1 fluid drachm	„	54·68	grains of water.
1 minim	„	0·91	„

"*Relation of Weights of the British Pharmacopœia to Metric Weights.*

"1 pound	equal to	453·5925	grammes.
1 ounce	„	28·3495	„
1 grain	„	0·0648	„

"*Relation of Measures of the British Pharmacopœia to Metric Measures.*

"1 gallon	equal to	4·543487	litres.
1 pint	„	0·567936	„
1 fluid ounce	„	0·028396	„
1 fluid drachm	„	0·003549	„
1 minim	„	0·000059	„

Proposed additions to, or discontinuance of Board of Trade standards.

The question how far it may be expedient to add to or to discontinue any of the existing Board of Trade standards, and to exercise the powers given for these purposes in sections 6 and 7 of the Standards Act of last session, 29 & 30 Vict. cap. 82., may next be referred to.

Avoirdupois weights.

With respect to any additions which it may be deemed expedient at the present time to make to the existing legal secondary standards of avoirdupois weight, the addition of decimal multiples and part of the pound weight may first be considered.

Decimal scale of multiples and parts of avoirdupois pound.

The Standards Commission of 1841 recommended in their Report the following decimal multiples and parts of the pound avoirdupois:—

100 lbs. and 200 lbs., if judged necessary.

lbs.	lbs.	lbs.	lbs.	lbs.
50	40	30	20	10
5	4	3	2	1
0·5	0·4	0·3	0·2	0·1
0·05	0·04	0·03	0·02	0·1
0·005	0·004	0·003	0·002	0·001

It remains for the existing Standards Commission to determine whether or how far they adhere to this recommendation of the Commission of 1841. It would appear from the notes laid before the Weights and Measures Committee of 1862 by the Astronomer Royal, that he now doubts the expediency of such a recommendation; and that upon the whole he thinks it best to leave the weights and measures undisturbed so far as regards the question of a decimal or a binary scale (see notes, S. 68). Since this recommendation was made by the Commission of 1841, there does not appear to have been any such expression of public opinion calling for the introduction of a decimal scale of the multiples and parts of the pound weight avoirdupois as might warrant its adoption in addition to a substitution for the existing septimal and binary scale; and the practice and experience of this Department afford no ground for suggesting its expediency.

Question of standard 3½ lb. weight.

Whilst, however, the correspondence of this Department does not show a single instance of an application to stamp and verify any avoirdupois weights of the decimal scale, or to establish decimal standards, there have been many applications to stamp and verify a 3½ lb. standard weight. The last of such applications, dated 1st September 1863, was from the Clerk of the Peace of the East Riding of Yorkshire, and he stated that "weights of 3½ lbs. were much used by "tradesmen in the East Riding of Yorkshire." The Comptroller-General replied that such a standard weight, not being a part or multiple but the fraction of a multiple of the avoirdupois lb., was not sanctioned by law, and that a 3½ lb. weight could not therefore be verified at the Exchequer.

An obvious and serious objection to a 3½ lb. weight being established as a standard and legalised for use arises from its similarity in size to a 4 lb. weight, for which it might frequently be fraudulently substituted without much risk of detection at the time. In the present scale of avoirdupois weights there is so marked a difference in the size of the several weights that such an attempt at fraud could hardly occur.*

10 lb. standard weight.

It has been already stated that a 10 lb. weight has been deposited at the Exchequer and established as a legal standard since 1825, but that it has never been used for verification of other 10 lb. weights, such not being comprised in the ordinary sets of avoirdupois weights sent to the Department for comparison and verification. The existence of the 10 lb. standard must be well known to the principal manufacturers of weights and measures, by whom the local standards are used, and by whose agency they are verified at this Department. The fact of no application having been made to verify a 10 lb. weight appears, therefore, to be a conclusive argument that no such local standard is required with the existing septimal scale.

Decimal grain standard weights recommended.

But the addition to the number of legal secondary standards of a decimal series of multiples of a grain, from 1,000 grains to 1 grain inclusive, appears to be more imperatively required, and especially under the new regulations of pharmaceutical weights, under which there is no intermediate unit between the grain and the ounce of 437·5 grains. At present the smallest standard avoirdupois weight is the

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* Preface, p. xvii.

* That this is not a theoretical but a practical objection may be seen by showing that even with the present series of weights similar fraudulent practices are continually met with.

In the printed Annual Reports to the Magistrates of Manchester, by Mr. Mellor, the Chief Inspector of Weights and Measures in that city, he has from time to time called attention to the common practice, not only of selling goods previously made up in parcels (such as pounds of sugar, &c.) which are knowingly short of the declared weight, but also of having a weight or other substance at the selling end of the scale, by which purchasers are frequently defrauded. He states also that he has frequent complaints from persons who have been charged for more than the goods purchased really weighed or measured. (1)

It would appear that although the Bread Act, 6 & 7 Will. 4. cap. 37. makes it imperative, under penalty, on all shopkeepers, &c. to weigh bread sold in the presence of the purchaser, when required, there is no such legislative enactment applicable to weighing or measuring other goods; and that when a purchaser has once paid his money for goods sold to him by a dishonest trader, which are short in weight or measure, he has practically no remedy.

(1) Reports, 1848-49, 1861-62.

Appendix II.—*continued.*

$\frac{1}{2}$ dram, equivalent to the unmanageable fractional and decimal numbers, $13\frac{43}{64}$ or 13·546875 grains. It can hardly be desirable to establish a standard weight for ordinary commercial purposes lower than 1 grain. An addition to the number of secondary legal standards of decimal grain weights down to 1 grain inclusive, as shown in the list at page 6, and comprehending 13 distinct weights, was recommended in the Report of the Standard Committee in 1854. It may now be suggested that they should be formally established as standards, and that the use of the remaining eight weights of the decimal parts of a grain be authorized. These small decimal grain weights will be found very useful in Departmental comparisons of standard and other weights, and indeed they will be absolutely necessary for ascertaining minute differences in such comparisons, more especially now that a definite allowance for error is to be sanctioned by law. They are also probably much required for scientific, chemical, and other purposes, where very precise accuracy is required. The whole series of decimal grain weights is applicable to avoirdupois, troy, and bullion weights, the grain being the only weight common to all.

Troy weights; contemplated abolition of troy scale.

Whilst recommending the revision of the standard of avoirdupois weight and troy weight, and a modified adoption of the decimal scale, the Commission of 1841 had in view the ultimate removal of the troy scale then in use. The recommendation that the decimal scale should be applied to troy weight was carried into effect by the passing, in 1853, of the Act 16 Vict. cap. 29. The Act recited that "the weights now ordinarily used in sales of gold and "silver are the troy ounce and other weights being mul- "tiples or decimal parts of such ounce," and authorized the construction of decimal bullion standards, being multiples and parts of the troy ounce, declared to be the unit of such decimal bullion weights. These bullion standards were deposited at the Exchequer in 1855, when they were authorized as supplementary to the other standards then in the Exchequer. The Astronomer Royal subsequently stated, in his notes to the Committee on weights and measures in 1862, that "the troy pound is practically expelled." It has been also shown that the use of troy weights for medical purposes was formally discontinued by lawful authority in 1864.

Considerations why discontinuance of troy weights inexpedient at the present time.

Considering, however, that bullion weights, which are decimal multiples and parts of the troy ounce, are established by law as supplementary only, not in substitution of the former troy standard weights, consisting of the troy pound and its parts descending in an almost unbroken binary series to the grain; that at the present time the number of sets of local standard troy weights, verified at the Exchequer since 1834, and now outstanding so far as can be ascertained, amounts to 138, of which 98 were for this kingdom and 40 for the colonies, whilst 13 sets only of decimal bullion standards have been verified; that troy weights are still extensively and almost exclusively (except by the principal bullion dealers) used by tradesmen and private individuals for determining the weight of gold and silver; and that cases continually may occur in which the weight of gold and silver can be more accurately expressed by the binary system of troy weights than by the decimal system of bullion weights (see, for example, the equivalents of proposed gold coin weights in the following table); it is doubtful whether it may be expedient now to recommend the discontinuance as legal secondary standards of any of the Board of Trade standard troy weights, as distinct from the bullion standards, except the troy pound.

Except the troy pound, to be discontinued as practically useless.

The troy pound has now become practically useless, except as a weight of 12 ounces, and the time appears to have arrived when it may cease to be a legal standard of weight and to be discontinued as a Board of Trade standard. The weight of gold and silver being everywhere expressed in ounces, when any greater multiples of the troy ounce than the 6 oz. weight, which would remain the largest weight in a set of standard troy weights, may be required, these may be found amongst the decimal multiples of the ounce contained in the list of bullion standards.

Gold coin weights, suggested standards of.

It may, perhaps, be desirable that secondary standards for gold coin weights, from 100 sovereigns downwards, may be constructed and legalized. These are now much used by bankers and others, though they are not stamped as duly verified. Sovereign and half-sovereign weights are now verified and stamped at the Mint, under the powers formerly given by an Act of 1774, although, strictly speaking, that Act applies only to guinea or half-guinea weights. It appears that 542 coin weights were so stamped in 1861 and 466 in 1862.*

Proposed scale and equivalent

The following scale of standard gold coin weights, consisting of 12 distinct weights, would probably be found the most convenient:—

—		Troy.			Bullion Weight.	Avoirdupois.
		oz.	dwt.	gr.	oz.	gr.
Standard weight of 100 sovereigns equal to -	-	25	13	13	25·677083&c.	12,325
,, ,,	50	12	16	18½	12·8385 ,,	6,162·5
,, ,,	40	10	5	10	10·2708 ,,	4,930
,, ,,	30	7	14	1½	7·7031 ,,	3,697·5
,, ,,	20	5	2	17	5·1354 ,,	2,465
,, ,,	10	2	11	8½	2·5777 ,,	1,232·5
,, ,,	5	1	5	16¼	1·2838 ,,	616·25
,, ,,	4	1	0	13	1·0270 ,,	493
,, ,,	3	0	15	9¾	0·7703 ,,	369·75
,, ,,	2	0	10	6½	0·5135 ,,	246·5
,, ,,	1	0	5	3¼	0·2567 ,,	123·25
,, ,,	½	0	2	13⅝	0·1283 ,,	61·625

Measures capacity.

The additions to the standard measures of capacity recommended by the Standards Commission of 1841 were as follows:—

$\frac{1}{6}$ gallon, as a measure of the wine bottle.
3 gallons.
5 gallons.
9 gallons.

Proposed standard wine bott and half wine bott

As there are already standard measures of 1 gallon, 2, 4, and 8 gallons, new standards of 3, 5, and 9 gallons hardly appear to be now required, the measure of any one of them being easily ascertained by taking two of the existing standards. But the establishment of a standard measure of $\frac{1}{6}$ gallon for the wine bottle is most desirable,* and it is suggested that a standard measure of $\frac{1}{12}$ gallon for the half wine bottle be also added.

And fluid ounce stan ard weigh

The existing standard measures of capacity from the bushel or 8 gallons down to the *gill* or $\frac{1}{4}$ *pint* can be used both as dry measures and for liquids. But it appears to be necessary to establish legal standards for smaller liquid measures of capacity than the gill or $\frac{1}{4}$ pint, such smaller measures being continually used for medical, chemical, and other purposes, and being also required for ascertaining the differences of standard and other measures of capacity when compared and verified. It is therefore suggested that it be expedient to add the following standard measures of capacity for liquids to the existing Board of Trade standards:—

4 fluid ounces equal to $\frac{1}{40}$ gallon, or $\frac{1}{5}$ pint,
2 fluid ounces ,, $\frac{1}{80}$ gallon, or $\frac{1}{10}$ pint,
1 fluid ounce ,, $\frac{1}{160}$ gallon, or $\frac{1}{20}$ pint, and equal to 60 minims.

and that the Department should be supplied with graduated minim measures, to be duly verified, for the use of the office, and in order to ascertain and note any actual difference in the comparison of standard measures of capacity. These graduated minim should, for the purpose of observation, be made of glass. It does not appear to be desirable that a smaller standard measure of capacity than a liquid ounce should be legalized.

Measures length: proposed new stand ards, including su divisions o the yard.

The addition to the standard measures of length recommended by the Commission of 1841 are as follows:—

Measures and beds of 1 foot, the bed having divisions into inches, tenths of inches, and tenths and hundredths of feet.
,, ,, 2 feet, similarly divided.
,, ,, 1 yard, the bed divided into halves, quarters, eighths, and sixteenths, and also into tenths and hundredths.
,, ,, 10 feet, the bed divided into feet and tenths of feet.
,, ,, 22 yards (the chain), divided into links.

There is no experience or further information in this Department to warrant any opinion being expressed upon the expediency of establishing standard measures of length of 10 feet and 22 yards. But there can hardly be a doubt of the expediency of establishing legal secondary standards of the subdivision of a yard, consisting of a 2 feet and

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* See Report on Exchequer Standards, 1863, p. 16.

* There appears to be no practical difficulty in the manufacture of wine bottles of an uniform and accurate size. In a lately published advertisement of a firm of wine merchants, whose business would appear to be so extensive that they state their weekly average of sales now reaches nearly 5,000 dozens of wines and spirits, they announce as follows:—"The Size of Bottles. It is of the utmost importance that "the bottles which contain wines and spirits should be of equal measure. "We have, therefore, made arrangements for our bottles to be cast so "that six shall hold an imperial gallon, and we guarantee, in every case, "that this quantity is given."

Appendix II.—*continued.*

1 foot standards, further subdivided into inches and parts of inches.

These standards might be legalized as measures of length only, without specifying the form of the standards. For primary standards, or for scientific purposes, they would probably be constructed as line standards. But the local standards of length for comparing and verifying the measures of length in ordinary use will probably continue to be constructed as at present, with rods for the end measures, adapted to the beds upon which the subdivisions may be marked.

It is, however, suggested that no subdivision of the inch less than one-tenth should be allowed upon the ordinary local standards, but only upon the line standards to be used as official standards, or for scientific or special purposes. The assistance of a microscope or magnifying glass is required for comparing measures of length so small as the hundredth part of an inch, and the local standards should be adapted for the eye only.

It is also advisable that no more subdivisions than are actually required should be marked upon these subdivided measures of length, in order to avoid not only additional labour and difficulty being imposed upon the officers of the Department in comparing and verifying these standard measures, but also delay in completing their verification, and the risk of error in the verification of numerous measures of subdivision.

The following additions to the secondary legal standard measures of length of the Board of Trade are therefore proposed, being in addition to the standard measure of 10 feet, divided into feet and tenths of feet, and the chain of 22 yards, divided into links, as already recommended by the Standards Commission:—

Subdivided Standard Measures of Length.

A standard yard, being a line measure, divided into a half-yard and 3 feet, with one foot subdivided into inches, one inch being subdivided into half, quarters, and eighths; another inch into twelfths; and a third inch into tenths; and one-tenth into hundredths of an inch.

A standard yard, being a rod or end measure, with its bed divided into 3 feet, and one foot into inches; one inch being subdivided, into half, quarters and eighths; another inch into tenths; and a third inch into twelfths.

A 2-feet standard, being a rod or end measure, with its bed divided into 2 feet, and one foot similarly subdivided.

A 1-foot standard, being a rod or end measure, with its beds similarly subdivided.

Summary of proposed additions, &c. to standards.

It may be convenient here to recapitulate the several additions here suggested to be made, and the number of existing Board of Trade standards:—

	Number of suggested additional standards.
Page 7. Decimal grain weights (1,000 gr. to 1 gr.)	13
„ 8. Gold coin weights (100 sov. to ½ sov.)	12
„ „ Liquid measures of capacity - -	5
„ „ Measures of length (also subdivided) -	6
	36

This additional number would be reduced to 35 by the discontinuance of the troy pound as a standard, suggested at page 10.

Metric weights and measures: information respecting proposed.

In connexion with the question of adding to the number of existing legal secondary standards, it remains only to refer to the subject of Metric weights and measures, not with the view of expressing any opinion, or of making any suggestion as to the expediency of including Metric weights and measures, in the additions to be made to the number of the "Board of Trade Standards," but with the object of placing before the Commission some further information respecting the Metric system, and its progress, since the publication of the Report of the Select Committee on Weights and Measures, 1862, already referred to in Mr. Chisholm's Report on Standard Weights and Measures, page 35.

In Report of Committee on Weights and Measures, 1862.

Whilst the principal recommendation of the Committee of 1862 was the introduction of the Metric system into this country, and that its use should be allowed, concurrently with the Imperial system, until the Metric weights and measures should be generally adopted, they further recommended a Department of Weights and Measures in connexion with the Board of Trade, and that such Department "should take such measures as may from time to time promote the use and extend the knowledge of the Metric "system in the Departments of Government and among "the people."

Bill of 1864, to establish Metric standards, &c.

In the session of 1864 a Bill was introduced into the House of Commons, "to render permissive the use of "the Metric System of Weights and Measures in this "country." A copy of this Bill is appended. See (B.) Its purpose was to establish the Metric system on a full equality with the Imperial system, the last clause proposing to enact that all the provisions regarding Imperial weights and measures should apply to Metric weights and measures.

The Bill declared the platinum metre, in the possession of the Royal Society, to be the legal metric standard of length, and the platinum kilogram, in the Royal Observatory at Greenwich, to be the legal weight of 1,000 grammes; the several decimal parts and multiples of the metre and the kilogram, as well as of the are, or unit of superficial measure, of the litre, the unit of capacity, and of the gramme, the unit of weight (these three units being derived from the metre), were set forth in a schedule annexed to the Bill, which also stated their Imperial equivalents.

Probable number of additional standards proposed by this Bill.

The Bill provided that copies of the metre and kilogram, together with a standard litre, and such multiples and parts as the Board of Trade should judge expedient, should be established as legal secondary standards.

The effect of this provision would have probably been to add the following number of metric standards to the existing Imperial standards:

4 Standard Metric Measures of length, viz.:—
1 metre, divided into decimetres, centimetres, and millimetres, or tenths, hundredths, and thousandths.
2 decimetres, divided into decimetres, centimetres, and millimetres.
1 decimetre, divided into centimetres and millimetres.
1 metric chain of a dekametre, or 10 meters, divided into 50 links of 2 decimetres.

2 „ Cubic ditto, viz.:—
1 cubic decimetre, or unit of litre.
1 cubic centimetre, or unit of gramme.

29 „ Weights, viz.:

	Kilograms.	Hectograms.	Dekagrams.	Grammes.	Decigrams.	Centigrams.	Milligrams.
1 each of	10						
	5	5	5	5	5	5	5
	2	2	2	2	2	2	2
	1	1	1	1	1	1	1
	1	1	1	1	1	1	1

18 „ Measures of capacity, viz.:—
For dry goods—1 dekalitre.
5 litres.
2 litres, or double litre.
1 litre.
½ litre, or 5 decilitres.
2 decilitres.
1 decilitre.
½ „
8

For liquids—1 dekalitre.
5 litres.
2 „
1 litre.
5 decilitres.
2 „
1 decilitre.
½ „ or 5 centilitres.
2 centilitres.
1 centilitre.
10

53 standards.

This probable list of Metric standards is taken from the engraved and coloured "List of Metric Weights and "Measures," published under the authority of the International Decimal Association. It will be observed that the largest standard of weight is 10 kilograms, equal nearly to 22 lbs. avoirdupois, and that there are six duplicate standard weights of the kilogram, and each decimal part of the kilogram, which are necessary for this decimal scale, in order to complete the intermediate integral numbers from 1 to 10.

Opposed by Government: provisions of amended Bill, and Metric Act, 1864.

The establishment of the Metric system, as provided in this Bill, was objected to by the Government, and the Bill was amended by the President of the Board of Trade, so as only to legalize contracts made in terms of the Metric system, the equivalents in imperial weights and measures of such Metric terms being set forth in a schedule. The Bill so amended, passed as the Act 27 & 28 Vict. cap. 117. A copy of this Act is appended. See (C.)

Clause for establishing Metric standards, proposed in Standards Bill, 1866.

In the last session, during the progress of the Standards Bill through the House of Commons, notice was given by Mr. Ewart of a motion:—"That it be an instruction to "the Committee on the Bill to provide for the gradual "introduction of the Metric system of weights and mea-

"sures into the United Kingdom." In consequence, however, probably of the late hour at which the Standards Bill passed through its several stages in the Commons, during the protracted discussion on the Reform Bill, Mr. Ewart's motion was not pressed.

When the Standards Bill was passing through the House of Lords, a deputation of the advocates of the Metric system had an interview with the President of the Board of Trade. They represented that the Metric Act required amendment, as, although it is lawful to make contracts by Metric system, and to buy and sell, &c., yet if material Metric weights and measures are used, the parties become liable to a penalty for using weights and measures not stamped. They wanted to have standard Metric weights and measures, with local copies, &c.; and for this purpose it was proposed by them that Earl Fortescue should move the insertion of the following clause after sect. 10 of the Standards Bill:—

"That the custody of any standard of length, capacity, or weight obtained in conformity with the provisions of the Metric Weights and Measures Act, 27 & 28 Vict. cap. 117, and of all apparatus, books, and documents used in connexion therewith, or relating thereto, shall be intrusted to the aforesaid Weights and Measures Department of the Board of Trade, and that the warden, clerks, and officers of that department shall discharge the same duties and have the same power and authority in regard to the Metric and to the Imperial weights and measures."

Conclusive objections against insertion of this proposed clause.

Against the insertion of this clause there was the obvious objection that so important a change as placing the Metric system upon an equality with the Imperial weights and measures should be considered by Parliament as a distinct proposition, in a Bill to amend and extend the Metric Act of 1864, and should not be attempted to be carried out by inserting a single clause in a Bill having for its sole object the transfer of the Department of Weights and Measures from the Exchequer to the Board of Trade. Earl Fortescue's motion was consequently not pressed.

Notice of motion in session 1867, upon the subject.

The following notice of motion now stands in the Order Book of the House of Commons for the next session:—

"Mr. Ewart. Weights and Measures (Metric system). Re-appointment of the Select Committee to facilitate the introduction of the Metric system of Weights and Measures."

Rests with Commission whether or not to express an opinion.

Under these circumstances, the propriety of expressing any opinion upon the question of the expediency of facilitating or promoting the more complete introduction of the Metric system of weights and measures into the kingdom, is left for the consideration of the Standards Commission.

Suggested deposit at the office of verified copy of the litre, the unit of metric capacity.

It is, however, suggested, that as a verified copy of the kilogram, the unit of the Metric weights, has been already deposited in this department, and that steps have been taken also for the construction and deposit of a verified metre, the primary unit of length and of the Metric system, it may be desirable that a duly verified copy of the litre, the unit of Metric capacity, should also be constructed and deposited in the Standard Weights and Measures Department of the Board of Trade.

(Signed) H. W. Chisholm,
Standards Department, Warden.
October 5, 1866.

Postscript:—Cases involving legal construction of Metric Act.

1. Legality of use of Metric weights, &c. in shops.

P.S.—Since the date of the above paper it has been considered desirable on two different occasions to ask the opinion of the law officers of the Crown on the legal construction of the Metric Act. The first case involving the legal construction of the Metric Act of 1864 was brought under the notice of the Standards Department by the Inspector of Weights and Measures in the county of Surrey, and was reported to the Board of Trade by the Warden of the Standards on 12th December 1866, as follows:—

The inspector entered a tradesman's premises in Southwark and found there a variety of French and English weights, all mixed together. The French Metric weights had originally been English Imperial weights, but had been plugged with lead to make them equal to French weights. The Metric weight was marked with paint on one side, whilst the mark denoting the British Imperial weight remained on the other side. Thus the inspector found one weight marked 4 kilo. on one side and 7 lbs. on the other. The tradesman defied the Inspector to touch them, alleging that the Metric Act permitted their use, but gave him no power to inspect them. On bringing the matter before the local magistrates, they said that the Metric Act was loosely drawn, and dismissed the case; and they advised the inspector not to seize the Metric weights. The result of this decision is that any person in this district may now use false weights and measures, calling them Metric. The inspector is powerless, and the defrauded public have no redress.

This case having been subsequently again brought to the notice of the Board of Trade, they directed Mr. Chisholm, by a Minute dated the 24th January 1867, to give his opinion upon the stated defect in the Metric Act, so that if were defective, either the Act should be amended or Metric Standards should be provided.

Before executing these directions, Mr. Chisholm requested the Inspector to furnish him with the fullest details of the case, His letter in reply is as follows:—

"2, West Square, St. George's Road,
"January 28, 1867.

"Sir,

"In answer to yours of the 26th instant, I beg most respectfully to inform you that on the 28th March last I visited the shop of Messrs. Jacobs Brothers, furriers, &c., Union Street, Borough, and on examining their weights I found four called by them metric or French weights, unjust, also an English weight, unjust. I seized the five weights, and the case came before the magistrates at the Newington Sessions House on the 11th April 1866, and was dismissed, the defendants producing the Metric System Act, 27 & 28 Vict. cap. 117. I may also state that Messrs. Jacobs have many English weights in their possession, and both English and French weights were together when I made the seizure. Goods are *bought* as well as *sold* by this firm, and in my opinion the present state of the law gives the trader every opportunity to cheat with impunity, and I cannot see my way clear to prevent it, the inspectors being powerless so far as the Metric system goes.

"The word 'dealing' in the Metric Act may be construed into that for which it was never intended. Every person *deals* with his butcher, baker, &c.; therefore why not one trade use Metric weights as well as another? I may not have read the Act of Parliament correctly, but certainly that is my present opinion.

"I am, &c.
(Signed) "James Strugnell,
"Inspector of Weights and Measures.

"To the Warden of the Standards,
"Board of Trade,
"6, Old Palace Yard."

Mr. Chisholm's Report to the Board of Trade upon the Legal Construction of the Metric Act, and the question whether that Act requires to be amended, or whether Metric Standards should be provided.

Mr. Chisholm's Report to Board of Trade on this case, and the question of Metric standards.

The legal decision as to the construction of the Metric Act, to which attention has been drawn, was reported to the Board of Trade by Mr. Chisholm in his letter of 12th December 1866, as an illustration rather of the defective administration of the law relating to weights and measures than as a defect in the law itself. I entertain no doubt that the decision given by the Newington magistrates was hasty and ill-considered, and that if they had done their duty properly they would have convicted the offender and declared the Metric weights forfeited.

A further report upon the subject, from the inspector of weights and measures, dated 28th January 1867, which has been prepared at my request, is appended. I do not concur in the construction of the word "dealing."

There can be no doubt as to the intention of the Legislature in passing the Metric Act. In the Bill as originally introduced by the advocates of the Metric system into the House of Commons in the session of 1864, not only contracts made in terms of the Metric system were legalized, but also the use of Metric weights and measures, to which all the laws relating to Imperial weights and measures, including standards, were made applicable. A copy of this Bill is appended. (See B.) The Government objected to the use of Metric weights and measures and of Metric standards, and amended the Bill to legalize contracts only, and to provide for the computation of Metric quantities by their equivalents in Imperial weights and measures, a schedule of such equivalents being annexed to the amended Bill. In this form the Bill became law, and even the advocates of the Metric system have always admitted and complained that the Metric Act does not permit the use of Metric weights and measures, and contend that it should be amended in order that their use should be allowed. This is shown in the appended copy of a letter from the late President of the Board of Trade, dated 15th June 1866. See (D.)

The provisions of the Metric Act appear to be clear, as may be seen from the appended copy. See (C.)

There are two distinct enactments only:—

1. To legalize *contracts or dealings* made in terms of the Metric system.

2. To compute, determine, and express weights and mea-

Appendix II.—*continued.*

sures of the Metric system by their equivalents in Imperial weights and measures, according to a table in the schedule annexed to the Act.

But there is no enactment which can be construed as allowing the use of Metric weights and measures.

If this construction of the Act be correct, it appears to be imperatively necessary that steps be immediately taken to stop and correct the mischievous effects of the decision of the Newington magistrates. This decision has paralysed the exertions of the inspectors of weights and measures, not only in that district, but, as I am informed, in the surrounding districts. It may be desirable that the subject be accordingly referred to the Home Department for their consideration, and to be dealt with as they may judge fit.

The question of the amendment of the Metric Act, by legalizing Metric weights and measures as well as Metric standards, is a far larger and more important question, and deserves very serious consideration.

There can be no middle course between prohibiting the use of material Metric weights and measures, and by sanctioning their use as well as Metric standards, to place the Metric system upon a footing of equality in all respects with the Imperial system of weights and measures. This is now the avowed object of the advocates of the Metric system, but it is a temporary object only, an instalment of what they require. They proclaim openly that they contemplate the compulsory substitution, at no distant time, of the Metric for the Imperial system.

But grave objections exist against the sanction by law of the concurrent use of both Metric and Imperial weights and measures. Many complaints are already made against the present complicated system of Imperial weights and measures, and the complication would be greatly increased. It would also tend much to facilitate fraud, by affording the means of substituting one weight or measure for another of nearly similar size, a fraudulent practice which is already common, and difficult either to guard against or obtain redress for. It would also be contrary to the principle upon which the laws relating to weights and measures have been based ever since the time of the Conquest, that of uniformity of weights and measures.

The question of the number of standards should also be considered, not so much as affecting the business of the Department by adding to the number of official standards and comparisons and verifications, which could be easily met, but as affecting the number and expense of local standards, and the consequent increase of the business connected with them, and the difficulties in transacting such business. A sufficient notion of the additional number of standards that would probably be required as compared with the existing number may be formed from the following statement;—

—	Weights.			Measures.		Gas Standards.		Total.
	Avoirdupois.	Troy.	Decimal Bullion.	Of Extension.	Of Capacity.	Weight.	Measures.	
Existing standards -	16	15	30	1	10	1	4	77
Metric standards required.	29			6	18	..	..	53

A detailed list of Metric standards that would probably be required if sanctioned by law, excluding gas measuring standards on the Metric system, is appended.*

Although there are now 77 distinct weights and measures in a *complete* set of standards, there are only 27 weights and measures in what is termed a *full set*, ordinarily provided as local standards, and consisting only of avoirdupois weights and measures of extension (or length) and capacity. On an average it may be stated that there are 30 Imperial weights and measures in each set of local standards provided for the several places in the United Kingdom, for which places 1,175 sets have been provided and officially verified. In round numbers, 35,000 standard weights and measures have been so provided for the several localities.

In this number the sub-standards authorized by law to be used throughout Ireland, are not included. The sub-standards are declared by law to be equal to the local standards to all intents and purposes. But they are verified in the several localities only, and no information of their number, condition, or accuracy has ever yet been furnished or become known to this Department.

It has been already proposed to add largely to this number of existing Imperial standards, and for this purpose the subject has been referred to the consideration of the Standards Commission. Suggestions have been made for the following additions:—

	Number of proposed Additional Standard Weights and Measures.
Decimal grain weights (1 gr. to 1,000 gr.)	- 13
Gold money weights (½ sov. to 100 sov.) -	- 12
Liquid measures of capacity - -	- 5
Measures of length (also subdivided) -	- 6
Total -	- 36

If these suggestions be carried into effect, and sets of the new standards provided for all the places now supplied with local standards, the number of Imperial standard weights and measures now outstanding will be more than doubled.

The further result of providing all these districts with Metric standards would be that 62,075 additional standard weights and measures must be furnished to the several localities and used by the inspectors.

But in truth to sanction by law the concurrent use of the two systems of weights and measures can be justified only upon the ground of its being a temporary evil, and as eventually leading to the substitution of the Metric for the Imperial system. The advocates of the Metric system insist on the great advantages to the public which would result from this change. Upon the question of the advantages of the Metric over the Imperial system there are great differences of opinion, to which I need not now further allude, except to state—

1. That I deny that there is any real advantage in the metre over the yard, *as a standard unit*, or in what is termed *a natural constant* (which, indeed the metre has been proved *not* to be), over a fixed standard, that is to say, a standard fixed by usage. In this last respect, I consider the yard and the metre to be upon a footing of perfect equality.

2. That whilst admitting the advantage of the decimal scale in all calculations and matters of account, affecting weights and measures, as well as money, I deny either the advantage or the convenience of its exclusive adoption in the transactions of business, or otherwise, when material things are to be weighed or measured, and especially when divided. The present binary scale of division appears to be far more useful, and I believe it to have been adopted because it was what people wanted.*

3. At the same time, it may be admitted that the Metric system has what the Imperial system has not,—a simplicity in the scale of multiples and parts of its several units, and symmetry in the relations between the units of length, capacity, weight, and coinage; though it is not very obvious that the public gain much practical benefit from this symmetry.

4. A real advantage would certainly arise from the adoption in this country of the Metric system, that, as it is now adopted by so many other countries, international transactions of business must necessarily be much facilitated. But this advantage would be felt to a limited extent only, and would not be felt at all in by far the greater number of cases in which weights and measures are used in this country.

The real questions to be decided are, is the substitution of the Metric for the Imperial system of weights and measures practicable in this country? Is there any likelihood of the Metric system being generally and voluntarily adopted? Is there any power in an Act of Parliament to compel its adoption against the wishes of the people? It appears to me that these questions can be answered only in the negative.

The principle hitherto acted on in the laws relating to weights and measures of the kingdom has been to legalize those already adopted and in most general use throughout the country, and by prohibiting all others, to establish uniformity of weights and measures throughout the whole country. Parliament has confirmed what the people have chosen as generally most convenient. The compulsory imposition in the country of a new and untried system would be a reversal of this process, the introduction of a wholly different principle of legislation on weights and measures. If attempted, it would, probably, rouse a spirit of opposition throughout the greater part of the country. And how is it to be enforced, and by whom? Has the multitude of Acts of Parliament ever succeeded in compelling uniformity

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* See List of Metric Standards, page 11.

* The following illustration may be given of this remark:—I had lately occasion to employ an intelligent working ivory turner, and on examining the inch rule which he used, found the inch divided into 2, 4, 8, 16, 32, and 64 parts. I asked him if he ever used an inch rule divided into 10ths and 100ths? He said he did not, and knew no workman who did.

I may add, also, the quaint illustration of the Astronomer Royal, that no law could compel a rustic to call for a tenth part of a quart of beer!

Appendix II.—*continued.*

of weights and measures, even under the established system? Can it be expected that the Government, who have always shown an entire apathy on the subject of weights and measures, will ever take stringent steps to carry out or compel the observance of an unpopular law? I confess, however, that I do not see any immediate prospect of the Metric system being thus practically put to the test in this kingdom.

The obstacles to its introduction and exclusive adoption appear to me far too great. The working classes, generally, would probably be clamorous against it. It may perhaps deserve consideration whether the organization of the Trades Unions throughout the country may not afford the means of obtaining some information upon this point, by inquiries to be made of their officers through the Home Department or otherwise.

Upon the whole, and particularly at the present time, I concur in the opinion of the Astronomer Royal in his last letter to me, dated 13th December 1866:—

"The Metric system is I think put upon an excellent footing, fair to all parties."

I would also draw attention to some practical and judicious notes of the Astronomer Royal, bearing upon this question, which was laid before the Committee on Weights and Measures, 1862, though not printed with their Report. They were subsequently printed in the Parliamentary Return, which contains Mr. Chisholm's Report on the Exchequer Standards.

It will be necessary that the consideration of the Government should be given to this subject, as the following notice of motion now stands in the Order Book of the House of Commons, for the approaching session:—

"Mr. Ewart. (Weights and Measures, Metric system). Re-appointment of the Select Committee, to facilitate the introduction of the Metric system of Weights and Measures."

The question of Metric standards may perhaps, also be considered by the Standards Commission, in the event of their appointment as contemplated by the Treasury minute of of the 26th February 1866, and the Board of Trade minute 3rd September 1866, under the subject of "what additions to the existing standards are now required," which is one of the points proposed to be referred to them. For this purpose the Warden of the Standards, in the series of preliminary papers which he has prepared for the proposed Commission, has included such information as appeared to him requisite to be laid before them, and it may be expedient also to include a copy of this minute.

(Signed) H. W. Chisholm,
January 31, 1867. Warden of the Standards.

Case submitted to Law Officers of the Crown.

Upon the receipt of this Report, the Board of Trade, by a minute of the 5th February 1867, requested Mr. Chisholm to prepare a case for the Law Officers, and to obtain their opinion as to the proper construction of the Metric Act. This was done as follows:—

Construction of Metric Act.

Case for the Opinion of the Law Officers of the Crown.

Section 21 of the Act 5 & 6 William 4. c. 63, relating to weights and measures enacts "That any person who "shall use any weight or measure other than those authorized by this Act" (viz., Imperial weights and measures), "or some aliquot part thereof, as herein-before described, "or which has not been so stamped as aforesaid" (viz., by the inspector, after comparison, and being found to correspond with the copies of the standards), "except as herein-"after excepted, or which shall be found light or otherwise "unjust, shall, on conviction, forfeit a sum not exceeding "five pounds; and any contract, bargain, or sale made by "any such weights and measures shall be wholly null and "void; and every such light or unjust weight or measure so "used, on being discovered by any inspector so appointed "as aforesaid, shall be seized, and, on conviction of the "person using or possessing the same, shall be forfeited."

27 & 28 Vict. cap. 117.

The following enactments are contained in the Metric Weights and Measures Act, 1864, entitled "An Act to "render permissive the use of the Metric System of "Weights and Measures:"—

Section 2. "Notwithstanding anything contained in any Act of Parliament to the contrary, no contract or dealing shall be deemed invalid or open to objection on the ground that the weights or measures expressed or referred to in such contract or dealings are weights or measures of the Metric system, or on the ground that decimal subdivisions of legal weights and measures, whether Metric or otherwise, are used in such contract or dealing."

Section 3. "The Table in the schedule hereunto annexed shall be deemed to set forth, in terms of the weights and measures in force in this country, the equivalents of the weights and measures therein expressed in terms of the Metric system, and such table may be lawfully used for computing, determining, and expressing in weights and measures, weights and measures of the Metric system."

There is now no provision by law for Metric standards, or for duly stamping material Metric weights and measures. But the question has arisen whether, under the provisions of the Metric Act, the use of material Metric weights and measures is allowed by law, or whether any person using such Metric weights and measures is liable to have such weights and measures seized by an inspector of weights and measures, to conviction, and to forfeiture, as provided for in section 21 of the Act 5 & 6 William 4. cap. 63.

Your opinion is therefore requested,

1. Is the use of material Metric weights and measures legal under the provisions of the "Metric Weights and "Measures Act, 1864?"

2. Do the provisions of section 21 of the Act 5 & 6 William 4. cap. 63 remain in full force, notwithstanding the provisions of the Act 27 & 28 Vict. cap. 117, and is any person using material Metric weights and measures legally liable to have them seized by an inspector of weights and measures, to conviction, and to forfeiture, as provided by the first-named Act?

Opinion of the Attorney-General and the Solicitor-General.

Their opinion.

1. We are of opinion that the provisions of the Metric Weights and Measures Act, 1864, prevents any contract or dealing from being invalid or open to objection, because the measures expressed or referred to are Metric weights or measures, and to this extent section 21 of 5 & 6 William 4. is repealed; but—

2. We think a person using material weights and measures is liable to have them seized, and to conviction, and forfeiture of the weights, under the 5 & 6 William 4. cap. 63.

(Signed) John Rolt.
John B. Karslake.

Lincoln's Inn, March 4, 1867.

A copy of this opinion was immediately sent to the inspector of the county of Surrey, and steps taken to make it publicly known.

2. Legality of officially verifying Metric Weights and Measures, and of charging Fee.

2. Legality of officially verifying Metric weights and measures, and of charging Fee.

The second case in which the opinion of the law officers of the Crown has been taken upon the legal construction of the Metric Act, 1864, was considered to be desirable by the Standards Commission at their meeting of 23rd June 1868, when the subject of the official verification of Metric weights and measures was under their consideration. It is as follows:—

Case for the Opinion of the Law Officers of the Crown.

1. On the Legality of officially verifying Metric Weights and Measures, and of the Possession and Use of Metric Weights and Measures by Persons otherwise than for the purposes of buying or selling, or Conveyance or Carriage of Goods.
2. On the Legality of charging a Fee for Official Comparisons of Weights and Measures, not being Copies of the Official Standards for the Use of the Local Inspectors.

I.

Construction of the Metric Act, 1864, and Standards Act, 1866, as to the Legality of verifying Metric Weights and Measures in the Standards Department, and the Possession of Metric Weights and Measures, and their Use by Persons for scientific Researches or otherwise, not being for the Purposes of buying or selling, of Carriage or Conveyance of Goods.

Case for the Opinion of the Law Officers of the Crown.

The following opinion of the Attorney-General and the Solicitor-General was given on 4th March 1867, as to the legality of using Metric weights and measures. (*See* previous case and opinion):—

The case thus referred to the law officers was drawn in reference to the *use of Metric weights and measures in shops and places liable to the visits of the local inspectors*, and to the seizure, &c. of such weights and measures "on being "discovered by any inspector," under s. 21.

The powers of inspectors to enter shops and other places and to inspect weights and measures are laid down in s. 28, and the clause extends the penalties to the *possession*, as well as the *use* of unjust weights and measures. The inspector is empowered "to enter any shop, store, ware-

Appendix II.—*continued.*

“ house, stall, yard, or place whatsoever within his jurisdiction, wherein goods shall be exposed or kept for sale, or shall be weighed for conveyance or carriage, and there to examine all weights, measures, steelyards, or other weighing machines, and to compare and try them with the copies of the Imperial Standard weights and measures required or authorized to be provided under this Act; and if upon such examination it shall appear that the said weights and measures are light or otherwise unjust, the same shall be liable to be seized and forfeited; and the person or persons in whose possession the same shall be found shall on conviction forfeit a sum not exceeding 5*l*.,” &c.

It has been reported to the Standards Commission that certain manufacturers in this country, such as the makers of locomotives and marine engines, who receive orders with the specifications made out on the metric system, use metric measures for their manufacturing operations, and that in like manner analytical chemists use Metric weights. These persons do not use metric weights and measures for the purpose of weighing or measuring goods for sale, or for conveyance, or for carriage, yet they may be used on premises where goods are sold, and are therefore open to the visits of inspectors.

The question has now arisen whether such manufacturer, or artizan, chemist, or scientific person would act illegally and be subject to a penalty for possessing or using Metric weights and measures in his workshop or other place not open to the visits of the inspectors, or in a place open to their visits, *such Metric weights and measures not being used for weighing or measuring goods for sale or purchase, conveyance or carriage.*

Your opinion is requested accordingly, (1).

A further question has arisen as to the legality of verifying Metric weights and measures in the Standards Department, such metric weights and measures being required to be used for scientific researches or otherwise, and not for the purposes of buying and selling goods, or weighing them for conveyance or carriage.

There are now deposited in the Standards Department copies of the French units of metric length and weight, the standard metre and the standard kilogram, which have been or are now being duly verified and authenticated by comparison with the French Standards. But there is no provision by law for constituting these copies of the French Standards, as legal Standards of weights and measures in this country.

Section 11 of the Standards Act, 1866, 29 & 30 Vict. c. 82, is as follows:—

“In addition to the performance of duties imposed on the Board of Trade by the Act, it shall be the duty of the Warden of the Standards to conduct all such comparisons, verifications, and other operations, with reference to standards of length, weight, or capacity, in aid of scientific researches, or otherwise, as the Board of Trade from time to time authorize or direct.”

Your opinion is therefore also requested, (2),

Whether the Board of Trade is restrained by the 5 & 6 Will. 4. c. 63. from authorizing and directing the comparison and verification in the Standards Department of Metric weights and measures with the copies of the French standards deposited there, such Metric weights and measures being required to be used for scientific researches, or otherwise, and not for the purposes of buying and selling goods, or weighing them for conveyance or carriage?

II.

Construction of the Standards Act, 1866, 29 & 30 Vict. c. 82., as to charging a Fee for the Official Verification of Weights and Measures, for Manufacturers and other private persons.

Previously to the passing of the Standards Act, 1866, and the transfer of the Weights and Measures Department to the Board of Trade, certain fees were charged for officially verifying copies of the Standards of Weights and Measures, and a stamp duty was payable on the indentures of verification.

Such fees and stamp duty were abolished by section 9 of the Standards Act, 1866, which is as follows:—

“9. From and after the passing of this Act, an indenture of verification of any standard or any indorsement on such indenture, shall not be liable to stamp duty, nor shall any fee be payable on the verification or reverification of any standard.”

At that period (and up to the present time) no weights and measures were verified in the Standards Department, except copies of the standards to be placed in the hands of the Local Inspectors of Weights and Measures, as local standards for the comparison and verification of commercial weights and measures, and the intention of the provision of section 9 was to relieve the county and local funds from the payment of the official fee and stamp duty.

In all cases of comparing and verifying weights and measures by the local inspectors, a fee is payable, a schedule of such fees being annexed to the Weights and Measures Act, 5 & 6 Will. 4. c. 63.

Section 11 of the Standards Act is as follows:—

“In addition to the performance of the duties imposed on the Board of Trade by this Act, it shall be the duty of the Warden of the Standards to conduct all such comparisons, verifications, and other operations, with reference to standards of length, weight, or capacity, in aid of scientific researches, or otherwise, as the Board of Trade, from time to time, authorize or direct.”

This clause was introduced in the Bill in its passage through the House of Lords, having formed no part of the Bill as originally drawn.

To give effect to this clause, it has been proposed that the Board of Trade should authorize and direct weights and measures to be officially verified for manufacturers of weights and measure, and other persons who may require great accuracy in their weights and measures, and that they should be compared and verified with the official standards, and that for such verification a fee should be charged, which may be collected by means of stamps, in pursuance of the Public Offices Fees Act, 1866.

Your opinion is therefore requested, (3),

Is the Board of Trade restricted under section 9 of the Standards Act, 1866, from charging a fee for the official comparison and verification of weights and measures, not being standards?

7, Old Palace Yard, 7 July 1868.

Opinion of the Attorney and Solicitor General.

1. We are of opinion that a manufacturer or artizan, chemist or scientific person, being in possession of or using Metric weights and measures, not for the purpose of weighing or measuring goods for sale or purchase, conveyance or carriage, is not liable to a penalty.

2. We are of opinion that the Board of Trade is not restrained by any existing statute from authorizing and directing the comparison and verification of Metric weights and measures which are to be used for scientific researches and otherwise, not for the purpose of buying and selling goods or weighing them for conveyance or carriage, with copies of French Standards.

3. We think that the Board of Trade is not authorized by the 11th section of the Standards of Weights Act to require a fee for the services to be rendered under that section. If the Board of Trade direct the Warden to conduct comparisons and verifications, it is his *duty* to perform this service, and in the absence of express authority we do not think that he can charge a fee for so doing.

Temple, July 25, 1868.

John B. Karslake.
Wm. Baliol Brett.

(A.) *See Note, p.* 8.

List of Standards and Apparatus connected with them, now at the Royal Observatory, Greenwich, which it is proposed to transfer to the Standards Office.

I.—Standards of Length and Apparatus.

Ramsden's 20-ft. standard.
East India 10-ft. standard.
Cape of Good Hope 10-ft. standard.
East India 6-inch bar.
Troughton's 5-ft. scale.
Bronze line bar - No. 6. (Generator.)
” ” - „ 12.

I.—Standards of Length and Apparatus—*cont.*

Bronze line bar - No. 41. With standard weight, No. 32.
” ” - „ 42. With standard weight, No. 33.
” ” - „ 44.
Brass bar - - „ 46.
” - - „ 47.
Flat brass bar - „ 48.
Tubular scale - „ 50.

Appendix II.—*continued.*

I.—Standards of Length and Apparatus—*cont.*

Donkin's copper -	No. 51.
Maudslay's copper -	„ 52.
May's alloy - -	„ 53.
Low moor iron -	„ 58.
Cast iron - -	„ 61.
„ - -	„ 62.
„ - -	„ 63.
Cast steel - -	„ 65.
„ - -	„ 66.
„ - -	„ 67.
End bar - -	„ 69.
12-inch end bar -	„ 77.
6-inch „	„ 80.
3-inch „ -	„ 82.
Glass bar.	

Line measures mounted as pendulums, with air-pump and other apparatus.

II.—Standards of Weight and Apparatus.

Box containing platinum troy pound and auxiliary weights used by Professor Miller.

Box containing Alchorne's troy pound, &c.

Box containing old troy pound weight.

Box containing pound weight of quartz.

Box containing platinum kilogramme.

Kater's large balance.

III.—Other Standards.

Copy of the "Jersey Standard."

American standards, with balance, in nine boxes.

G. B. Airy.

December 13, 1866.

(B.) *See pp.* 11 *and* 12.

February 18, 1864.

A Bill to render permissive the use of the Metric System of Weights and Measures in this Country.

Preamble.

WHEREAS for the promotion and extension of our internal as well as our foreign trade, and for the advancement of science, it is expedient to legalize the use of the Metric system of weights and measures: Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

Short title.

1. This Act may be cited as the "Metric Weights and Measures Act, 1864."

The use of Metric weights and measures allowed.

2. From and after the passing of this Act the weights and measures of the Metric system shall be legal weights and measures, and may be used for all purposes whatsoever.

Metre defined.

3. The length of that bar of platinum having the word "Metre" engraved upon it, in the possession of the Royal Society, and made in consequence of a resolution of the House of Commons, adopted on the fifteenth day of March, one thousand eight hundred and sixteen, shall at the temperature of melting ice, be the standard of the measure of length called the Metre; the decimal multiples and divisions of which, and their equivalents in Imperial measures, are set forth in the schedule hereunto annexed.

The are unit of superficial measure.

4. The Metric unit of superficial measure shall be the are, which is equal to one hundred square metres, or to a square dekametre, the decimal multiples and divisions of which and their equivalents in the Imperial measures, are set forth in the schedule hereunto annexed.

The litre unit of measure of capacity.

5. The Metric unit of measures of capacity, as well for liquids as for dry goods, shall be the litre, equal in capacity to a cubic decimetre, the decimal multiples and divisions of which, and their equivalents in the Imperial measures, are set forth in the schedule hereunto annexed.

The gramme unit of weight.

6. The Metric unit of weight shall be the gramme, being the weight of a cubic centimetre of distilled water at the temperature of its greatest density; the decimal multiples and divisions of which, and their equivalents in the Imperial weights, are set forth in the schedule hereunto annexed.

Standard kilogram of platinum.

7. The kilogram or kilo, being the weight of one thousand grammes, is hereby declared to be represented by the standard kilogram of platinum preserved in the Royal Observatory at Greenwich.

Double and half of principal measures and weights.

8. For the subdivision of the Metric measures and weights, it shall be lawful to use the double and half of all the aforesaid units, and of their decimal multiples and divisions,

Copies and models to be made and deposited in certain places.

9. Exact copies of the aforesaid metre and kilogram, together with a standard litre and of such multiples and parts thereof as the Committee of Her Majesty's Privy Council for Trade shall judge expedient, shall within six months after the passing of this Act, be made under the direction of the said Committee, and after being duly verified, shall be sent to the Lord Mayor of London, the Lord Mayor of Dublin, the Lord Provost of Edinburgh, and to all counties, shires, stewartries, ridings, divisions, cities, towns, liberties, and places in which by law, copies and models of the standard Imperial weights and measures are or are required to be kept; and to such other places and persons as the President of the Committee of Privy Council for Trade may from time to time direct.

Customs duties may be collected by Metric weights and measures.

10. The rates and duties of the customs on any goods or merchandize arriving from any country in which the Metric weights and measures are in use, shall, if the person paying or chargeable with the duty thereon shall so require, be collected by the Metric weights and measures; and so soon as conveniently may be after the passing of this Act, accurate tables shall be prepared and published under the direction of the said Committee of the Privy Council for Trade, in order that the several rates and duties of customs and excise and other Her Majesty's revenue may be adjusted, and, when required by the parties, made payable according to the respective quantities of the Metric weights and measures.

Magistrates may provide copies of Metric weights and measures for reference.

11. All judges, magistrates, and other person or persons who now are or shall hereafter be authorized by law to order or provide copies of the Imperial standard weights and measures shall at all times hereafter have like power and authority to order or provide copies of the Metric standard weights and measures, and to charge the expense thereof upon the fund or funds, money or monies, that would have been liable in case it had been copies of standard Imperial weights and measures that had been ordered or provided.

Provisions regarding Imperial weights and measures to apply to Metric weights and measures.

12. All and every the provisions and provision which are or may be hereafter by law in force with respect to the inspection, verification, reverification, stamping, counterfeiting, and modes of conviction, with the penalty or penalties relating thereto, of the Imperial weights and measures, shall apply to and be in force with regard to the Metric weights and measures in every respect as if the Metric weights and measures were comprised in and designated by the Imperial weights and measures in the Acts relating to such inspection, verification, reverification, stamping, counterfeiting, and modes of conviction, and the penalty or penalties relating thereto as aforesaid,

Schedule to which this Act refers.

Metric Names.	Metric Equivalent.	Imperial Equivalents.		
Linear Measures—		Inches.	Yards.	Miles.
Myriametre - - -	10,000 metres - - - - - -	..	10,936·331	6·214
Kilometre - - -	1,000 „ - - - - - -	..	1,093·633	0·621
Hectometre - - -	100 „ - - - - - -	..	109·363	0·062
Dekametre - - -	10 „ - - - - - -	..	10·936	..
Metre - - - -	The unit - - - - - -	39·371	1·094	..
Decimetre - - -	$\frac{1}{10}$th of a metre - - - - -	3·937	..	..
Centimetre - - -	$\frac{1}{100}$th „ - - - - -	·394	..	..
Millimetre - - -	$\frac{1}{1000}$th „ - - - - -	·39	..	..
Square Measure—		Square Yards.	Roods.	Acres.
Hectare - - -	100 ares, or 10,000 square metres - - -	11,963·333	9·885	2·471
Dekare - - -	10 ares, or 1,000 square metres - - -	1,196·033	·988	·247
Are - - - -	The unit - - - - - -	119·603	·099	·925
Centiare - - -	$\frac{1}{100}$th of an are, or 1 square metre - -	1·196	..	..
Measure of Capacity—		Pints.	Gallons.	
Kilolitre - - -	1,000 litres, or a cubic metre - - -	1,760·773	220·097	..
Hectolitre - - -	100 „ - - - - - -	176·077	22·010	..
Dekalitre - - -	10 „ - - - - - -	17·608	2·201	..
Litre - - - -	The unit, or a cubic decimetre - - -	1·761	.220	..
Decilitre - - -	$\frac{1}{10}$th of a litre - - - - -	·176	..	..
Centilitre - - -	$\frac{1}{100}$th „ - - - - -	·018	..	..
Weights—		Grains.	Ounces.	Pounds.
Ton - - - -	1,000 kilograms, the weight of a cubic metre of water.	..	..	2,204·714
Quintal - - -	100 kilograms - - - - -	..	..	220·471
Myriagram - - -	10 „ - - - - -	..	..	22·047
Kilogram - - -	1,000 grams - - - - - -	..	35·275	2·205
Hectogram - - -	100 „ - - - - - -	..	3·528	..
Dekagram - - -	10 „ - - - - - -	..	·353	..
Gram - - - -	The unit, the weight of a centimetre of water -	15·433	..	..
Decigram - - -	$\frac{1}{10}$th of a gram - - - - -	1·543	..	..
Centigram - - -	$\frac{1}{100}$th „ - - - - -	·154	..	..
Milligram - - -	$\frac{1}{1000}$th „ - - - - -	·015	..	..

Appendix II.—*continued.*

(C.) *See p.* 11.

27 & 28 VICT. CAP. 117.

AN ACT TO RENDER PERMISSIVE THE USE OF THE METRIC SYSTEM OF WEIGHTS AND MEASURES.

[July 29, 1864.]

WHEREAS, for the promotion and extension of our internal as well as our foreign trade, and for the advancement of science, it is expedient to legalize the use of the Metric system of weights and measures: Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

Short title.

1. This Act may be cited as the "Metric Weights and Measures Act, 1864."

Contracts may be made in terms of the Metric system.

2. Notwithstanding anything contained in any Act of Parliament to the contrary, no contract or dealing shall be deemed to be invalid or open to objection on the ground that the weights or measures expressed or referred to in such contract or dealing are weights or measures of the Metric system, or on the ground that decimal subdivisions of legal weights and measures, whether Metric or otherwise, are used in such contract or dealing.

Equivalents of Metric weights and measures in terms of weights and measures.

3. The Table in the schedule hereto annexed shall be deemed to set forth, in terms of the weights and measures in force in this country, the equivalents of the weights and measures therein expressed in terms of the Metric system, and such Table may be lawfully used for computing, determining, and expressing, in weights and measures, weights and measures of the Metric system.

SCHEDULE to which this Act refers.

SCHEDULE of Tables of the values of the principal denominations of measures and weights on the Metric system expressed by means of the legalized denominations of measures and weights in Great Britain and Ireland.

MEASURES OF LENGTH.

Metric Denominations and Values.		Equivalent in British Denominations.			
	Metres.	Miles.	Yards.	Feet.	Inches. Decimals.
Myriametre - -	10,000	6 or	376 10,936	0 0	11·9 11·9
Kilometre - -	1,000		1,093	1	10·79
Hectometre - -	100		109	1	1·079
Dekametre - -	10		10	2	9·7079
Metre - - -	1		1	0	3·3708
Decimetre - -	$\frac{1}{10}$				3·9371
Centimetre - -	$\frac{1}{100}$				0·3937
Millimetre - -	$\frac{1}{1000}$				0·0394

MEASURES OF SURFACE.

Metric Denominations and Values.		Equivalents in British Denominations.	
	Square Metres.	Acres.	Square Yards. Decimals.
Hectare, *i.e.*, 100 ares.	10,000	2 or	2,280·3326 11,960·3326
Dekare, *i.e.*, 10 ares	1,000		1,196·0333
Are - - -	100		119·6033
Centiare, *i.e.*, $\frac{1}{100}$ are.	1		1·1960

MEASURES OF CAPACITY.

Metric Denomintions and Values.		Equivalents in British Denominations.					
	Cubic Metres.	Quarters.	Bushels.	Pecks.	Gallons.	Quarts.	Pints. Decimals.
Kilolitre, *i.e.*, 1,000 litres -	1	3	3	2	0	0	0·77
Hectolitre, *i.e.*, 100 litres -	$\frac{1}{10}$		2	3	0	0	0·077
Dekalitre, *i.e.*, 10 litres - -	$\frac{1}{100}$			1	0	0	1·6077
Litre, - - - - -	$\frac{1}{1000}$						1·76077
Decilitre, *i.e.*, $\frac{1}{10}$ litre - -	$\frac{1}{10000}$						0·176077
Centilitre, *i.e.*, $\frac{1}{100}$ litre - -	$\frac{1}{100000}$						0·0176077

WEIGHTS.

Metric Denominations and Values.		Equivalents in British Denominations.				
	Grams.	Cwts.	Stones.	Pounds.	Ounces.	Drams. Decimals.
Millier - - - -	1,000,000	19	5	6	9	15·04
Quintal - - - -	100,000	1	7	10	7	6·304
Myriagram - - -	10,000		1	8	0	11·8304
Kilogram - - -	1,000	(or 15,432·3487 grains)		2	3	4·3830
Hectogram - - -	100				3	8·4383
Dekagram - - -	10					5·6438
Gram - - - -	1	(or 15·432 grain)				0·56438
Decigram - - -	$\frac{1}{10}$					0·056438
Centigram - - -	$\frac{1}{100}$					0·0056438
Milligram - - -	$\frac{1}{1000}$	(or 0·01543 grain)				0·00056438

(D.) *See p.* 12.

THE RIGHT HON. T. MILNER GIBSON TO MR. CHISHOLM.

3, Hyde Park Place, Cumberland Gate,
London, June 15, 1866.

MY DEAR MR. CHISHOLM,

A DEPUTATION came to me yesterday about the Metric system. They say, first, that the Act as passed requires amendment, as although it is lawful to make contracts by the Metric system, and to buy and sell, &c., yet, if used by the parties, they become liable to a penalty for using weights which have not been stamped. That provision appears to remain in full force.

They want a standard metre and local copies, &c.

The enclosed clause* Lord Fortescue proposes to move on Weights and Measures Transfer Bill in the House of Lords. It is drawn up in this form to avoid touching on the privileges of the Commons by initiating a charge in the Lords. Will you kindly look into this?

Yours, &c.
(Signed) THOS. MILNER GIBSON.

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* Enclosure.—Clause proposed to be inserted in the Bill after Section 10. See page 12.

APPENDIX III.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—PROPOSED MODE of COMPARISON and REVERIFICATION of BOARD OF TRADE STANDARDS.

CONTENTS.

Page
Comparison, &c., of official Standards of Weights and Measures, now first authorized by statute - - 18
Comparison of Exchequer Standards in 1758 - - „
Proposed mode of comparison of Board of Trade Standards :
By whom comparisons to be made - - - 19
Standard Weights ; description of balances to be used :
  Weights for determining the value of a division of each index scale of the balances - - - „
  Mode of proceeding in the comparison of Standard weights - - - - - - - - „
  Formula for noting the process and recording its results - - - - - - - 20
  Avoirdupois weights, how to be compared and verified in relation to the Imperial Standard - - „
  Troy weights „ „ „ - „
  Bullion Standards „ „ „ - 21
Standard measures of capacity „ „ - „
Gas measuring standards „ „ - „
Standard measures of length :
  Preparation of subdivided Standard yard, and new comparing microscopic apparatus - - - „
  Standard yard - - - - - - „
  Formula for noting the comparison of Standard measures of length and its result - - - „
Report of comparisons to Standards Commission - - 22

(A.)—Verification of balance decimal grain weights - 22
(B.)—Method of weighing ; correspondence of Professor Miller and Astronomer Royal with this Department, October 5, 1855 - - - - 23

Page
(C.)—Comparison and adjustment of Bullion Standards ; Correspondence of Professor Miller with this Department in 1855 - - - - - 23
(D.)—Proceedings relating to the preparation of a subdivided Standard yard, and to the new microscopic comparing apparatus for measures of length :
  I. Extract of Minutes of proceedings at meeting of members of the late Standards Commission at the Exchequer, on June 15, 1866 - - - - - - 24
  II. Mr. Chisholm's Report, dated June 18, 1866, on the completion of the new comparing apparatus; its first use for verifying a primary Standard yard for the colony of Victoria ; exact deviation from Standard stated, its allowance recommended, and to be noted in indenture of verification - „
  III. Comptroller-General to Treasury, June 18, transmitting the above report - - 25
  IV. Treasury reply, June 22, sanctioning allowance of deviation, to be noted in indenture of verification - - - - - „
  V. Warden of the Standards to Board of Trade, September 14, 1866, reporting Astronomer Royal's approval of Minutes, June 15, 1866 (I.) ; consequent addition required to new comparing apparatus; immediate commencement of verification of official Standards, and assistance of one or more of the principal makers of standards 26
  VI. Treasury to Board of Trade, October 25, 1866, sanctioning the consequent expense to be incurred - - - - „

Comparison, &c., of official standards now first authorized by statute.

THE comparison and verification of the official standards of weights and measures has now for the first time been authorized and directed by legislative enactment, under sec. 4 of the Act 29 & 30 Vict. cap. 82.

The standards of avoirdupois and troy weight and the standard yard have been in use since 1825, and the standard measures of capacity since 1834.

There is no record of any previous comparison or reverification of the official Exchequer standards, except in 1758, under the directions of Lord Carysfort's Committee. This comparison is referred to in Mr. Chisholm's report on the Exchequer Standards, dated 27th April 1863, page 11, which has been laid before Parliament. (No. 115 of 1864.)

Comparison of Exchequer standards in 1758.

The standards were compared with each other by Mr. Harris, the assay master of the Mint, on the 14th April 1758, and the results were as follows: they deserve notice, as showing the defects in the standards then in use at the Exchequer, after they had been used for verifying the local standards during a period of 170 years, from 1588 to 1758. It should be observed that this was nothing more than a comparison of the official standards one with another, and not with reference to any one fixed standard. In fact, there was then no such fixed standard, and consequently the Committee found so much difficulty in determining the true weight of the several Exchequer standards, as "there appeared such considerable difference in these "standard weights in whatever way they were tried," that they immediately turned their attention "to ascertain "some standard which should be uniform, and to preserve "a due proportion as well in its parts as in its multiples." The result was the making of the troy standard pound, which, *seventy-seven years afterwards*, in 1825, was declared by 5 Geo. 4. cap. 74, sec. 4, to be the "unit or only standard measure of weight," and which was destroyed in the fire at the Houses of Parliament in 1835.

Comparison of Exchequer Standards, on 14th April 1758.

Troy weights, 13 pieces.

2 of ⅛ oz.	One heavier than the other by ½ grain.
1 of ¼ oz.	Lighter than the two ⅛ oz. by ½ grain.
½ oz.	„ three preceding by ½ grain.
1 oz.	„ four „ ½ „
2 oz.	„ five „ ½ „
4 oz.	Agreeing very nearly with the six preceding.
8 oz.	„ seven „
16 oz.	„ eight „
32 oz.	Lighter than the nine preceding by 2 grains.
64 oz.	Agreeing very nearly with the ten preceding.
128 oz.	Heavier than the eleven preceding by 15 *grains*.
256 oz.	Heavier than the twelve preceding by 24 grains.

Avoirdupoi weights fla

$\frac{1}{16}$ oz.	An exact counterpoise to this was made.
⅛ oz.	Heavier than the two preceding by ¼ grain.
¼ oz.	Agreeing very nearly with the preceding three.
½ oz.	Heavier than the preceding four by ¼ grain.
1 oz.	Heavier than the preceding five by ¼ grain.
2 oz.	Lighter than the preceding six by ½ grain.
4 oz.	Agreeing very nearly with the preceding seven.
8 oz.	Agreeing very nearly with the preceding eight.
1 lb.	Agreeing very nearly with the preceding nine.
2 lb.	Heavier than the preceding ten by 2 grains.
4 lb.	Heavier than the preceding eleven by 8 grains.
8 lb.	Agreeing exactly with the preceding twelve.

Avoirdupoi weights, bell-shaped

1 lb.	Heavier than the flat weight by 3½ grains.
2 lb.	Lighter than the flat weight by 4 grains.
4 lb.	Agreeing exactly with the flat weight.
7 lb.	Lighter than the preceding three weights by 4 grains.
14 lb.	Lighter than the preceding four weights by 24 grains.
28 lb.	Lighter than the preceding five weights by 20 grains.
56 lb.	Agreeing very nearly with the six preceding.

Measures of capacity.

A bushel, time of Henry 7, with a copper rim, holding nearly three pints of water more than the other three bushels.

One bushel without a rim. One bushel, dated 16Q1—1091, not used (date of 1601 reversed). One bushel, dated 1601, used as a standard.	These three bushels agree. The standard bushel holds less than eight standard gallons by about half pint.

A coal bushel, marked 4 George 2.

One gallon, *temp*. Henry 7, contains less than the standard by two spoonfuls.

A gallon, 1601, with two E.s and crowns, contains less than the standard by two spoonfuls.

A gallon, 1601, with E. and a crown, used as a standard, holds less than four standard quarts by ¼ pint.

One quart, with two E.s and a crown, the two pints not quite filling this quart.

One pint, with two E.s and a crown. One pint, with E. and a crown, used as a standard.	These two pints agree.

Appendix III.—*continued.*

Measures of length.

One ell One yard	marked E., with a crown; standards.	Very coarsely made, the divisions on them not equal. The rods bent, and very bad standards.

One other yard, marked H. Supposed of the time of Henry 7, not used.

The divisions in the yard of Queen Elizabeth are of two inches. The octagon yard rod of Henry 7 is divided into 18, 12, 4, 3, 2, and 1 inches. The ell is 1¼ yard, or 45 inches in length.

Notwithstanding the defects all in these standards made in the reign of Queen Elizabeth, they continued to be used at the Exchequer until 1825, when they were superseded by the standards then established by law; the standards of capacity having been again replaced by others in 1834.

Mode of Comparison and Reverification of the Board of Trade Standards.

whom nparisons o be made.

It is proposed that the actual comparison be made by the officers of the Standards Department, with the assistance, if it be found requisite, of one or more of the principal manufacturers of weights and measures, or scale-makers. It is suggested that either Mr. Ladd or Mr. Oertling, of the firm of Ladd and Oertling, might be requested to assist in the necessarily numerous comparisons of the several standard weights; Mr. Short, of the firm of De Grave and Co., for the measures of capacity; and Mr. James Simms, of the firm of Troughton and Simms, for the measures of length, if their services should be required. Mr. Donkin may be called upon to furnish mechanical assistance in verifying the gas standards. In the several cases in which the standards may require adjustment, or new standards furnished, as the Commission may decide, the necessary orders may be given to these firms.

No time should be now lost in beginning the comparisons of the standards, which may be made as follows:—

Standard Weights.

Description of balances to be used.

The balances to be used are those supplied to the Department by Messrs. Ladd and Oertling in 1845, for comparing bullion weights.* They are finely poised upon agate bearings and are enclosed in plate-glass cases. At the end of the beam of each of these balances there is an index needle, which moves over an ivory scale, divided into 20 divisions, from 0 to 20 downwards.† The value of a division of each of these balances, or the exact weight represented by it, necessarily varies according to the state of the atmosphere, the condition of the balances, and the weights placed in the pans. The following values of a division are the means of those recorded at the comparison and verification at the Exchequer of the Mint weights on 23rd May 1865, with a bullion weight in each pan:—

Balances.

No.					Value of 1 Division of Index. grains.
1.	For comparing Bullion Weights,	500 oz. to 200 oz.,	or Avoirdupois	56 lbs. to 14 lbs.	0·44
2.	„ „	200 „ to 100 „	„	7 „ to 2 „	0·25
3.	„ „	100 „ to 2 „	„	1 lb. to 2 oz.	0·006
4.	„ „	1 „ to 0·001	„	1 oz. and under	0·002

Messrs. Oertling have been directed to examine these balances and to put them in the most perfect condition.

Weights for determining the value of one division of each index scale of the balances.

The smallest weights in use at the Exchequer are the decimal grain weights, from 0·01 grain to 1,000 grains, deposited at the Exchequer by Professor Miller in 1855, and made by Oertling. These, however, have not been constituted legal secondary standards, and upon trial were found not to be exact. They have therefore been sent to Messrs. Ladd and Oertling to be accurately adjusted, and may hereafter be verified among themselves in the Department. See (A).

The smallest of the legal secondary standards of the Department are the 0·005 ounce, 0·004 ounce, 0·003 ounce, 0·002 ounce, and 0·001 ounce of the bullion weights, being equal respectively to 2·4 grains, 1·92 grain, 1·44 grain, 0·96 grain, and 0·48 grain.

The errors assigned to these standards by Professor Miller are as follows:—

0·005 oz.	- -	0·00076 too light.
0·004 „	- -	0·00019 „
0·003 „	- -	0·00036 too heavy.
0·002 „	- -	0·00018 „
0·001 „	- -	0·00012 „

The following comparisons among themselves of these weights were made on 29th September last with balance No. 4. In order to ascertain the value of one division of the index scale, Mr. Chaney used the smallest decimal grain weight, 0·01 grain (which, however, had not then been verified). Its weight showed a variation of 2·5 divisions of the scale. One division, therefore, equalled 0·004 grain.

Compared Weight.	Comparing Weight.	Difference of compared Weight.	
		By Departmental Comparison.	By Professor Miller.
0·005 oz. ≏	0·004 and 0·001 oz. - - - -	−0·18 div., or 0·00072 gr. lighter - -	0·00069 gr. lighter.
0·005 oz. ≏	0·003 „ 0·002 oz. - - - -	−0·3 „ or 0·00120 gr. „ - -	0·00130 gr. „
0·004 oz. ≏	0·003 „ 0·001 oz. - - - -	−0·2 „ or 0·00080 gr. „ - -	0·00067 gr. „
0·003 oz. ≏	0·002 „ 0·001 oz. - - - -	+0·09 „ or 0·00036 gr. heavier - -	0·00006 gr. heavier.

These results agree so nearly that it may be assumed that these standard bullion weights are now as correct as when they left Professor Miller's hands. It may, therefore, be advisable for determining the value of a division of the index scale of balances Nos. 1 and 2 to use the two weights 0·004 ounce and 0·002 ounce separately, and to take the mean result. A smaller weight must necessarily be used for balances Nos. 3 and 4, so as not to move the needle out of the range of the index scale. For these balances the smallest decimal grain weight, 0·01 grain, when accurately verified, may most conveniently be used.

Amongst the bullion standards deposited at the Exchequer is a weight of 0·025 ounce, equal exactly to 12 grains. It is the smallest of these bullion standards that is equal to an integral number of grains. Messrs. Ladd and Oertling have been directed to furnish for the use of the Department, see (A), 12 weights of 1 grain each, 10 of 0·1 grain, and 10 of 0·01 grain, which may be accurately compared and verified with this 0·025 ounce bullion standard, and made exact, or their errors noted. These small weights will serve to ascertain the value of a division of any one of the index scales from time to time. They will also serve to verify the decimal grain weights.

All weighings will be made in air. The balances before being used will be tested both for sensitiveness and stability. Gauss' method of weighing, as recommended by Professor Miller, will be used. See (B.).

Mode of proceeding in the comparison of standard weights.

That method is as follows: the standard to be compared being placed in the left-hand pan, and the comparing standard in the right-hand pan, the division and fraction of a division which would be pointed out by the index if the beam were allowed to come to a state of rest is ascertained by taking the mean of the extreme of the vibrations, when this extent does not exceed the limit of the scale; much time is thus saved, and it is presumed greater accuracy attained. The standards are then changed and the resting point of the index is observed when the comparing standard is placed in the left hand pan. The same process is repeated three or six times, or as many times as may be thought necessary, and the mean resting point of each standard ascertained. Half the difference between these two means shows the difference of the weight of the compared standard and that of the standard with which it is compared, in divisions of the index, and, when converted into parts of a grain, shows the actual difference in weight.

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* See Report on Exchequer Standards, 1863, page 31.

† The ivory scales have since been altered; see App. V., p. 36.

Appendix III.—*continued.*

Formula noting the process and recording results.

The following form is proposed to note and record the process and its results:—

Date.	Compared Standard.	Comparing Standard.	Compared Standard. Divisions of Index Scale.					Comparing Standard. Divisions of Index Scale.					Difference of compared Standard in Divisions.*	Value of One Division in Grains or decimal parts.	Difference of compared Standard in Grains or decimal parts.
			Highest.	Lowest.	Sum.	Resting Point.	Mean.	Highest.	Lowest.	Sum.	Resting Point.	Mean.			
1866. Sept. 29.	1 lb. 1855, No. 34.	1 lb. 1855, No. 31.	10	10	20	10	10	10	10	20	10	10	No sensible difference.	—	—
			10	10	20	10		10	10	20	10				
			10	10	20	10		10	10	20	10				
	1 lb. 1824, No. 1.	1 lb. 1855, No. 31.	14·5	10	24·5	12·25	12·24	9·4	3·6	13	6·5	6·5	+2·87	0·0023 gr.	+0·006
			14·5	10·1	24·4	12·2		9	4	13	6·5				
			14 5	10	24·5	12·25		9·2	3·9	13·1	6·55				
			14·5	10	24·5	12·25		10·2	3	13·2	6·6				
			14·2	10·3	24·5	12·25		11·8	1	12·8	6·4				
			14·1	10·4	24·5	12·25		12	1	13	6·5				

In observing the vibrations of the index needle the first is disregarded, and the mean of the three next highest, as well as of the three next lowest, is taken and noted.

In the first instance of these comparisons the gilt gun-metal lb. No. 34 was compared with No. 31, and no sensible difference observed on the mean of three comparisons.

In the second instance the result of six comparisons shows the 1 lb. brass primary avoirdupois lb. of Captain Kater, constructed and verified in 1824 and deposited at the Treasury until 1865, when it was removed to the Exchequer, to be 0·0066 gr. in excess of the present Imperial standard pound.

For the reverification of the Board of Trade standards of weights, it may be expedient to take the mean of ten observations on two successive days, in order to determine the excess or deficiency of any compared standard.

The above formula is sufficient for all comparisons of any of the official standard weights with the standard itself when the latter is of true weight. In the comparison of the Board of Trade standards *with each other*, now to be made, it will be necessary, in order to ascertain the relation of the compared standard to the Imperial standard, to add to or deduct from the result thus obtained the error of the Board of Trade standard or standards with which it is compared. The form in which it is proposed to determine this last result will be next shown.

Comparison and Reverification of Board of Trade Standards.

Avoirdupois Weights.

1. For ascertaining their relation to the Imperial standard pound.

Let BT = Board of Trade Standard.
P = Imperial Standard.

Avoirdupoi weights, how to be compared and verifie in relation to the Imperial standard.

There are two gilt gun-metal copies of the Imperial standard pound deposited in the Standards Department: No. 31, of 1855, 0·000080 gr. heavier than the standard, and No. 34, 0·000089 gr. lighter. As the combined weight of the two standard pounds is thus correct to 0·000009 grain, their mean weight may be assumed to be equal to the imperial standard, and to form a true basis of comparison.

Formula for Comparison and Verification of the Official Standards of Avoirdupois Weight.

Compared Standards.	Comparing Standards.	Excess or Deficiency of Compared Standard.	Excess or Deficiency, in relation to the Imperial Standard, of Comparing Weights.	Net result.
		grain.	grain.	grain.
BT 1 lb. - - -	≏ Mean of No. 31 and No. 34 -	..	Nil.	BT 1 lb. ± = P
2 „ - - -	≏ „ -	..	Nil.	2 „ .. = 2 „
4 „ - - -	≏ „ and BT 2 lb.	..	..	4 „ .. = 4 „
7 „ - - -	≏ Nos. 31 and 34, BT 1 lb. and 4 lb.	..	..	7 „ .. = 7 „
14 „ - - -	≏ All the above, and 7 „	..	..	14 „ .. =14 „
28 „ - - -	≏ „ and 14 „	..	..	28 „ .. =28 „
56 „ - - -	≏ „ and 28 „	..	..	56 „ .. =56 „
8 oz., and exact counterpoise,	≏ No. 31 or 34 - - -	..	Nil.	8 oz. .. = $\frac{1}{2}$ „
4 „ „	≏ BT 8 oz. - - -	..	..	4 „ .. = $\frac{1}{4}$ „
2 „ „	≏ „ 4 „ - - -	..	..	2 „ .. = $\frac{1}{8}$ „
1 „ „	≏ „ 2 „ - - -	..	..	1 „ .. = $\frac{1}{16}$ „
8 dr. „	≏ „ 1 „ - - -	..	..	8 dr. .. = $\frac{1}{32}$ „
4 „ „	≏ „ 8 dr. - - -	..	..	4 „ .. = $\frac{1}{64}$ „
2 „ „	≏ „ 4 „ - - -	..	..	2 „ .. = $\frac{1}{128}$ „
1 „ „	≏ „ 2 „ - - -	..	..	1 „ .. = $\frac{1}{256}$ „
$\frac{1}{2}$ „ „	≏ „ 1 „ - - -	..	..	$\frac{1}{2}$ „ .. = $\frac{1}{512}$ „

2. For ascertaining the deterioration of these standard weights since their construction in 1825, this deterioration may be assumed to be expressed in their stated difference in relation to the Imperial standard. It is, however, to be observed that the primary avoirdupois pound (No. 1), constructed by Captain Kater in 1824,† and verified by him with the Imperial standard troy pound, and declared to be then 0·00048 grain more than 7,000 grains, has now been compared with No. 31 of 1855, and found to be 0·0066 grain heavier, as shown above in this page. This, however, is not to be taken as a final comparison. This avoirdupois pound No. 1 has never been used, and does not appear to be affected by oxidation. It will probably be carefully examined by the Commission and subjected to the most accurate comparison.

Troy Weights.

Troy weights.

For ascertaining the relation to the Imperial standard pound of 1855 the troy pound may be compared with the bullion standards of 10 oz. and 2 oz., verified by Professor Miller and deposited at the Exchequer in 1853. For this purpose the comparison of the troy weights should be preceded by the reverification of the bullion standards, in order to ascertain that they show no sensible deterioration. The comparison of the troy weights below the pound may be made on the same principle as the comparison of the avoirdupois weights. It should be observed that in addition to the official standard troy pound ordinarily used for comparison, there is another standard troy pound deposited at the Exchequer, which was most carefully verified

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* By Gauss's method of weighing, the result "in Divisions," and the consequent result "in Grains," is one-half the difference of the mean "resting" points of the compared and comparing standards.

† See Captain Kater's account, Phil. Trans. 1826.

Appendix III.—*continued.*

by Captain Kater, and has been only once used. This last standard should be minutely examined to see if it has been affected by oxidation since Professor Miller's examination in 1844, and how far it differs in weight with the working standard, as well as with the 10 oz. and 2 oz. bullion weights.

For the purpose of a more accurate comparison of the troy and bullion weights with the Imperial standard, it would be desirable that the original restored troy pound and the other auxiliary weights, all of platinum, which were constructed and carefully verified under the superintendence of the Commission of 1841, and referred to in their Report of 1854, should be deposited in the Standards Department.

Bullion Standards.

Bullion standards.

These standards should be accurately compared with each other in the same manner as the avoirdupois weights, in order to ascertain if there is any sensible deterioration in any of them since their verification in 1855; see (C.); and if not, it may be presumed that they now bear the same ascertained relation to the Imperial standard. If the decimal grain weights were accurately verified and established as legal secondary standards, the 10 oz. and 5 oz. bullion weights, weighing together 7,200 grains, might be compared with the standard pound No. 31 and the 200 decimal grain weight.

Standard Measures of Capacity.

Standard measures of capacity.

The Board of Trade standard gallon to be reverified by weighing its contents of distilled water against the 10 lb. gallon weights deposited in 1825 and in 1855. The comparison with the first-named 10 lb. weight would show any deterioration in the standard gallon; that with the 10 lb. weight of 1855 would determine the relation of the standard gallon to the Imperial standard.

The working standard bushel, quart, and pint to be compared with the original standard bushel, quart, and pint, verified by Captain Kater in 1824, and now at the Exchequer, but never used. And the original standard to be reverified by weighing the quantity of distilled water contained in it.

All measures of capacity below the gallon to be also compared by weighing their contents of distilled water.

In the comparison of measures of capacity due allowance to be made for any variation of the barometer, and of the temperature and moisture of the atmosphere. It may be sufficient to take the mean of three comparisons by measurement on two different days.

Gas Standard Measures.

Gas standard measures.

The gas standard measures to be thoroughly put in order and examined, and to be verified by passing cubic foot volumes of air from the standard cubic foot into the gas measures, and according to the following formula:—

FORMULA for the Comparison and Verification of Gas-measuring Standards.

Date of Comparison.	Denomination of Standard Compared.	Denomination of Comparing Standard.	Observations of Thermometers.		Trial of Scales of Standards Compared.			Pressure on Outlet of Comparing Standard in Inches of Water.	Difference of Compared Standard from Comparing Standard.	Difference of Comparing Standard from Imperial Standard.	Amount of Correction for Temperature and Moisture.	Difference of Compared Standard from Imperial Standard in parts of a Cubic Foot.
			Temperature of Compared Standard Bell.	Temperature of Outlet of Comparing Standard.	Back.	Front.	Mean.					
			In Degrees Fahrenheit.		In Cubic Feet.				In Cubic Feet.		Per Cent.	
1866. Oct. 10.	B.T. 1 foot Gas measurement.	B.T. Cubic foot, Bottle No. 2.	58°	59°	1	·98	·99	·1	+·002	−·01	−·25	−·00798

Standard Measures of Length.

Preparation of subdivided standard yard, and completion of new microscopic comparing apparatus.

The only measure of length hitherto legalized as a standard is the yard. The proceedings lately taken for the preparation of a subdivided standard yard, and relating to the new comparing microscopic apparatus for standard measures of length, will be found appended. See (D.)

This new microscopic apparatus was recommended in the Report of the Standards Committee, dated 14th July 1864; it was authorized by the Treasury on 25th July 1865, and its completion was reported by Mr. Chisholm on 18th June 1866. But it was adapted for the comparison of standard yards only.

The sanction of the Treasury having been signified on 25th October last, the necessary directions were given to Messrs. Troughton and Simms on 27th October for the construction of a new line standard yard, divided into half, quarters, eighths, and sixteenths, or nails; into three feet, with one foot subdivided into inches, one inch being subdivided into tenths and hundredths, another inch into half, quarters, eighths, and sixteenths, and a third inch into thirds and twelfths. The exact measure of a metre, a half metre, and tenths of a metre to be marked upon the bar, one decimetre being subdivided into centimetres, and one centimetre into millimetres.

Messrs. Troughton and Simms were at the same time directed to make the necessary alterations and additions to the new comparing apparatus, in order to adapt it for making comparisons with this new subdivided standard.

As it appeared that there was not sufficient or convenient space in the rooms now occupied by the Standards Department for the new comparing apparatus when enlarged, on application to the Board of Works, two more rooms have been allotted on the first floor of the adjoining old Norman tower, to which there is a communication from the Gas Standard room. These rooms are now being fitted for the purpose by the Board of Works.

Standard Yard.

Standard yard.

The relation to the Imperial standard yard of the Board of Trade standard yard of 1825, and any difference in deficiency of the rod as compared with the bed, as well as any deterioration in either of them, can be ascertained through comparison with the various standard yards of 1825 and 1855, now deposited in the Standards Department, and by means of the new micrometrical comparing apparatus.

The comparisons of the standards of length are proposed to be made in the following manner:—

The standards to be compared will be placed in their respective positions for the first comparison on the day preceding that on which the observations are to be made.

The standard to be compared will be placed nearest to the observer, and both standards will be placed and adjusted with the defining lines for observation at the focal distance of the microscopes, and with these lines parallel to the cobweb lines of the microscopes.

The mean of eight observations will be taken, or of more if considered necessary; the mean of three separate comparisons to be taken as one observation. An observation will be taken with each microscope alternatively, when the position of the bars will be changed. The observations may be taken in the following order and distinguished for noting thus:—

A will denote that the *front* of the bars is next to the observer.

A 1, with the left-hand microscope (L), the compared standard being next to the observer.

A 2, with the right-hand microscope (R), the compared standard being next to the observer.

A 3, with the left-hand microscope (L), the comparing standard being next to the observer.

A 4, with the right-hand microscope (R), the comparing standard being next to the observer.

B 1, 2, 3, and 4 will denote that similar observations are made with the bars reversed, and the *back* of each bar towards the observer.

Formula for noting the comparisons of measures of length, and the results.

The following formula for noting and recording the observations and results is proposed to be adopted. It is adapted for all comparisons of standard measures of length, either of line standards with line standards or of end standards with line standards, by means of the new contact apparatus, as shown in columns 6 and 7. This contact apparatus may be used with either a rod or its bed, both being taken to be end standards:—

Appendix III.—*continued.*

FORMULA for the Comparison and Verification of Standard Measures of Length.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
					In Micrometer Divisions.			In Decimal Parts of an Inch.				In Degrees of Fahrenheit.		
Date of Comparison.	Standard Compared.	Comparing Standard.	Temperature of Room, Fahrenheit.	Number denoting Microscope used, and positions of Standards.	Distance between lines of Contact Pieces and Compared End Standards.	Difference of Compared Standard from Comparing Standard, including Contact Pieces.	Difference of Comparing Standard from Compared Standard.	Value of one Division of the Micrometer.	Difference of Compared Standard from Comparing Standard.	Difference of Comparing Standard from Imperial Standard,	Difference of Compared Standard from Imperial Standard.	Standard Temperature of Compared Standard equivalent to Column 10.	Standard Temperature of Comparing Standard.	Actual Standard Temperature of Compared Standard.
1866.			°						+	+	—		°	°
Oct. 6	B. T. Imperial yard bed of 1824, brass, with steel terminations.	B. T. Line Standard, No. 30, of 1855, bronze.	62	A 1	653	695	42	0·00003	0·00126	0·000116	0·001144	3·66	61·66	65·32
			62	A 2	657	699	42	„	0·00126	„	0·001144	3·66	„	65·32
			62	A 3	658	700	42	„	0·00126	„	0·001144	3·66	„	65·32
			62	A 4	658	700	42	„	0·00126	„	0·001144	3·66	„	65·32
„ 8	Ditto	Ditto	64	B 1	653	694	41	„	0·00123	„	0·001114	3·57	„	65·23
			64	B 2	654	694	40	„	0·00120	„	0·001084	3·48	„	65·14
			64	B 3	654	695	41	„	0·00123	„	0·001114	3·57	„	65·23
			64	B 4	655	696	41	„	0·00123	„	0·001114	3·57	„	65·23
											0·009002	28·83		—
										Mean result -	0·001125	3·60		65·26

24 comparisons made, the mean of the three, taken at each position, being alone recorded.

The thermometric expansion of a bronze bar 36 inches in length is 0·000341 inch for every degree of Fahrenheit, and of brass 0·000344 inch. (See Astronomer Royal's Report, 1857, p. 61.)

A column is inserted to show the temperature of the room, although it hardly appears to be required, as the effect of the temperature would be imperceptible on the *relative* difference of two standard yards of brass and bronze compared at the same temperature.

Report of comparisons to Standards Commission.

So soon as the comparison of the official secondary standards shall have been completed by the officers of the Department, their relation to the Imperial standards thus determined, and their errors ascertained, the results will be reported at the earliest period to the Standards Commission for their consideration and decision. The question will then, if not sooner have to be determined whether the use of all these official standards for the comparison and verification of local standards should be discontinued, if found erroneous, until they shall be adjusted or renewed; or, should their use be continued, whether due allowance should be made for their ascertained errors. With respect to the avoirdupois and troy weights, the metal of which they are composed is brass, which has already been pronounced by the Standards Commission in their Report of 1854 as unfit for secondary legal standards, on account of its tendency to oxidation; the substitution of gun metal, coated with gilding by amalgam, has consequently been recommended for all standard weights. The expediency of giving the necessary orders at the earliest period for the construction of these new standard weights will doubtless be taken into consideration by the Commission.

(Signed) H. W. CHISHOLM.

October 12, 1866.

(A.) *See p.* 19.

VERIFICATION OF BALANCE DECIMAL GRAIN WEIGHTS.

When standard weights are compared for the purpose of verification in this Department, their differences from Imperial weight are first ascertained in divisions of the index fixed opposite to the ends of the beams of each of the Board of Trade balances. As it is necessary to ascertain the value in weight of one of these index divisions before the error in weight of the compared standard can be known, small balance weights, representing quantities from 1 to 0·01 grain, are employed in determining the value of one division of the index. This value varies from time to time according to the condition of the balances, the weights in the pans, the condition of the atmosphere, or other causes.

The small balance weights hitherto used had never been officially verified. They have now been accurately compared, and the following new balance weights have, therefore, been furnished to this Department by Ladd and Oertling, viz.,

12 new platinum weights of 1 grain each.
10 new aluminium weights of 0·1 grain each.
10 „ „ 0·01 „

All these new balance weights have been carefully compared with the bullion standard weights from 0·025 oz. (or 12 grains) to 0·001 oz. (or 0·48 grain). One weight of a grain, one of 0·1 grain, and two of 0·01 grain, were selected as representative weights, and their errors ascertained to 0·0001 grain; the verified grain weight was placed in a round box No. 7, the 0·1 grain in another round box No. 13, and the two weights of 0·01 grain in two other boxes, marked respectively Nos. 24 and 25. The remaining 11 weights of a grain, 9 weights of 0·1 grain, and 8 of 0·01 grain, were placed in a fourth round box, the whole four boxes being inclosed in a larger square box marked "Standard Balance "Weights." The actual weights of Nos. 7, 13, 24, and 25 are:—

No. 7	0·99511 grain, being	0·00489	grain in deficiency.
No. 13	=0·09951	„	0·00049	„	„
Nos. 14 & 25 each	=0·00966	„	0·00034	„	„

The following balance weights were also compared and placed in the "Standard Balance Weights" box:—

One gun-metal weight of 1,000 grains: correct to 0·01 of a grain.
„ „ 600 „ „ „
„ „ 300 „ „ „
„ „ 200 „ „ „
„ „ 100 „ „ „
„ „ 60 „ „ „
„ „ 30 „ „ „
„ „ 20 „ „ „
„ „ 10 „ „ „
One platinum weight of 6 grains: correct to 0·01 grain.
„ „ 3 „ „ „
„ „ 2 „ „ „
„ „ 1 „ „ „
One aluminium weight of 0·6 grain: correct to 0·005 grain.
„ „ 0·3 „ „ „
„ „ 0·2 „ „ „
„ „ 0·1 „ „ „
„ „ 0·06 grain: correct to 0·001 grain.
„ „ 0·03 „ „ „
„ „ 0·02 „ „ „
„ „ 0·01 „ „ „

(Signed) HENRY J. CHANEY.

Standards Department, Nov. 14, 1866.

Appendix III.—*continued.*

(B.) *See p.* 19.

METHOD OF WEIGHING.

PROFESSOR MILLER TO THE ASTRONOMER ROYAL.

(Extract.) October 7, 1853.

The method of weighing recommended by counterpoise, or Borda's method as it is commonly called, is in use at the Exchequer. I always use the method attributed to Gauss, which with exactly the same trouble gives a result twice as accurate as Borda's. In it, calling S and C the two weights to be compared, S is put in the left pan, C in the right, then C is put in the left pan, and S in the right. The distance between the two positions of equilibrium of the index in this method is twice as much as in Borda's; consequently as this distance serves to measure the difference between the weights, Gauss' method is twice as accurate as Borda's.

* * * * *

The balance should have no downward pointing index, but a scale opposite to the left-hand extremity of the beam, which should carry an index. The scale should have close divisions (I would make no attempt to estimate fractions of a division) numbered from 0 at one end to the other end, instead of 0 in the middle with perplexing right or left or + and —.

The business of the observer will then be to put the standard in the left pan, the copy in the right, and note the highest and lowest division at which the index appears stationary, then to do the same, the standard being in the right pan and the copy in the left. These four numbers, which, of course, should be entered in a book and preserved, give the difference between the standard and copy.

Let 0 be at the top of the scale, one division = u grains, no other unit of weight; p, q, the divisions at which the index is stationary, when standard is in left pan, copy in right pan; x, y, the divisions at which the index is stationary when the standard is in right pan, copy in left pan.

Then copy = standard + $\frac{u}{2}\left(\frac{x+y}{2} - \frac{p+q}{2}\right)$. The acceptance or rejection of the weight would of course depend upon the value of $\frac{u}{4}(x+y) - (p+q)$. The observations and computations are fully within the powers of the persons at present employed in this Department of the Exchequer.

It will be a greater advantage for weight-makers to possess weights the error of which is tolerably well determined, than if they were merely known to be not affected by a certain considerable error.

The error of a copy of the lb. would be known to within 0·005 grain by the above process, provided the temperature of the two weights were nearly equal at the time of making the comparison.

THE ASTRONOMER ROYAL TO THE ASSISTANT COMPTROLLER OF THE EXCHEQUER.

(Extract) October 10, 1853.

I advocate most strongly the process which Professor Miller proposes of having the inclination scale numbered continuously from end to end, and of terminating the operation by the formula $\frac{x+y}{2} - \frac{p+q}{2}$. I use the same principle in numerous cases with great gain of accuracy and convenience.

(C.) *See p.* 21.

COMPARISON AND ADJUSTMENT OF BULLION STANDARDS.

PROFESSOR MILLER TO MR. BOWEN.

7, Scroope Terrace, Cambridge,
August 22, 1855.

DEAR SIR,

I SEND you the following list of the errors of the adjusted weights as far as at the present moment I have been able to calculate them in decimals of a grain.

(Note.)—The actual errors here noted are corrected to those finally determined by Professor Miller, and stated at the conclusion of his report on the construction of the Imperial Standard Pound.

Ounce.	Grain.	
0·1	0·00038	too light.
0·2	0·00018	too heavy.
0·3	0·00037	„
0·4	0·00013	„
0·5	0·00013	„
Weight marked oz.	0·00015	„
1	0·00032	„
2	0·00053	too light.
3	0·00047	too heavy.
4	0·00016	too light.
5	0·00003	too heavy.
10	0·00042	„
20	0·00286	too light.
30	0·00138	too heavy.
40	0·02980	too light.
50	0·0054	too heavy.
100	0·0193	„
200	0·022	too light.
300	0·027	too heavy.
400	0·000	—
500	0·054	too light.

The weight of 10 lbs. is 0·112 grain too heavy. The kilogramme is 0·0012 grain lighter than the "kilogramme type laiton" of Paris.

When the largest balance has 300 ounces in each pan, one part of the scale is equal to 0·22143 grain.

When 500 ounces are in each pan, one part is equal to 0·19360 grain.

In the next largest balance with 10 lbs. in each pan, one part is equal to 0·1396 grain.

It is so late that I have not time to copy the other results before the post closes. I intend to send you them to-morrow.

I am, &c.,

John Bowen, Esq. (Signed) W. H. MILLER.

PROFESSOR MILLER TO MR. BOWEN.

DEAR SIR, Cambridge, August 23, 1855.

I HEREWITH send the errors of the smaller weights, which I could not do before the closing of the post yesterday.

Ounce.	Grain.	
0·001 (with a notch)	0·00012	too heavy.
0·001 (with a bit of gold fused on)	0·0001	„
0·002	0·00018	„
0·003	0·00036	„
0·004	0·00019	too light.
0·005	0·00076	„
0·01	0·00012	too heavy.
0·02	0·00066	too light.
0·025	0·00007	„
0·03	0·00000	—
0·04	0·00015	too heavy.
0·05	0·00008	too light.

For the smallest balance with a very small weight in each pan, 1 part equals 0·00296 grain. For ordinary comparisons it will be sufficient to assume the position of equilibrium of the index to be the mean of two extreme positions. When great accuracy is required it will be better to take for the position of equilibrium one fourth of (the sum of the first and third extreme added to twice the second extreme). This should be done in finding the value of a part in grains.

Here is an example. I put the reduced 20 oz. weight in the left pan of the smallest balance but one, and the unreduced 20 oz. in the right-hand pan. I found it requisite to put 0·03 grain in the left-hand pan to make it oscillate. The readings of the index then were:—

0·3 8·9 1

One fourth of the sum of the first and last of these numbers and twice the second is 4·77. I then added 0·1 grain to the weights in the left-hand pan; the readings then were:—

15·2 9·85 15·1

mean of 1st and 3rd, together with twice the second, 12·5.

The addition of 0·1 grain changes the position of equilibrium of the index from 4·77 to 12·5, or 0·1 grain is equivalent to 7·73 parts of the scale. Hence one part of the scale is equal to $\frac{0\cdot1 \text{ grain}}{7\cdot73}$ equal to 0·01294 grain.

I have further to observe that as the coating is of chemically pure gold, and therefore very soft, the weights should never be touched with the naked hand, but a bit of clean silk or leather should always be interposed. On this account your suggestion of employing a set of working weights deserves very serious consideration. Should this be adopted, I would recommend the old form of weights—bad certainly for standard, but good for the purpose in question. *i.e.*, weights with knobs to screw on with cavities wherein to insert small wire weights to make up the deficiency.

Yours, &c.

John Bowen, Esq. (Signed) W. H. MILLER.

MR. BOWEN TO PROFESSOR MILLER.

DEAR SIR, Exchequer, August 28, 1855.

IN forwarding to me the list of errors you found existing in the model bullion weights which have been compared and adjusted by you for the use of this office, I suppose your intention was merely that I should record them on the books of the office, not that you thought or advised that in making the comparisons of the copies of the models, I should attempt to take into account and allow for the errors you have pointed out.

A set of working standards has been ordered of Messrs. Ladd and Streatfield, and in verifying them I shall, as you have advised me, make ten comparisons between them and the electro-gilt standards. But your advice to make so large a number of comparisons does not extend, as I understood from you in conversation when you were here, to other cases in which you have expressed an opinion that one or two observations would be sufficient.

The remedy proposed by Mr. Miller, of the Bank, was calculated on the basis of $\frac{5}{1000}$ of an oz. upon the 1,000 oz. weight on the side of excess. In your letter to the Astronomer Royal, October 7, 1853, you stated that you preferred taking about $\frac{2}{5}$ of the remedy suggested in the different cases and allow it to range either above or below. I suppose I must follow your plan as nearly as I can.

Yours, &c.

To Professor Miller. (Signed) JOHN BOWEN.

Appendix III.—*continued.*

Professor Miller to Mr. Bowen.

7, Scroope Terrace, Cambridge,
August 31, 1855.

Dear Sir,

Of course in ordinary comparisons of weights it will be quite needless to take into account the small differences between the ounce weights and the weights they represent, *i.e.*, the errors of the gilt standards. Yet in doubtful cases it may be requisite to refer to the list of errors. It might happen, for example, that a weight maker sent a 300 oz. weight just less than the least allowance of error tolerated. The fact that the standard is 0·0233 grain too heavy might save it from rejection. Such cases, however, will occur but very rarely, most likely never.

Each of the working weights will, I think, require ten comparisons with the gilt standards down to five ounces; below that to one ounce four or six comparisons will be sufficient; below one ounce two comparisons will in all probability answer the purpose.

In the ordinary comparisons of weights sent to the Exchequer, I believe two weighings will be quite sufficient, that is, one weighing with standard in left pan, copy in right pan, and one with copy in left pan and standard in right pan.

The largest balance in its present state of adjustment, when the knob in the middle is turned as far to the left as possible, requires the addition of 0·6 grain to the left pan during the comparison of 300 oz. weights. In the comparison of 400 oz. weights about 1·4 grain should be placed in the left pan, and in the comparison of 500 oz. weights 2·6 grain should be placed in the left pan. It is very possible that a change of temperature may alter this.

The amount of "remedy" or allowable error in a weight ought to be determined by law. My recommendation carries no authority with it. Should any well grounded fear arise that weight makers would fraudulently make their weights less than the standard if any error in defect were allowed, this danger might be met by allowing a certain error or "remedy," one third of which should be in defect and two thirds in excess, or one fourth in defect and three fourths in excess, or in any other proportion that might be considered best.

The absolute rejection of a weight for being a very little too light is a great check to any attempt to make the weight very accurate.

Example of Record of Comparison.

In Left Pan.	In Right Pan.	Index Extremes.	Index Mean.
300 oz. standard -	300 oz. copy -	13·1 .. 9	11·05
300 oz. copy -	300 oz. standard	10·4 .. 16	13·2
		Difference	2·15

Copy is heavier than standard $\frac{2{\cdot}15}{2}$ parts, equal to 1·075 parts. But 1 part equal 0·22143 grain. Hence copy is 0·248 grain too heavy.

I have spoken to Mr. Oertling respecting a contrivance for checking the oscillations of the pans.

I am, &c.

John Bowen, Esq. (Signed) W. H. Miller.

P.S.—In my own observations I always observe three consecutive extreme positions of the index. The position of equilibrium of the index is then one fourth the sum of the first and twice the second position of the index. Example:—

In Left Pan.	In Right Pan.	Index Extremes.	Index Position of Equilibrium.
500 oz. standard -	500 oz. copy -	19·2 7·5 19	13·30
500 oz. copy -	500 oz. standard	7 11·6 7·1	9·32
		Difference	3·98

Copy is $\frac{3{\cdot}98}{2}$ or 1·99 parts lighter than the standard. With 500 oz. in each pan, 1 part equal 0·1936 grain. Hence copy is 0·385 grain lighter than standard.

(D.) *See p. 21.*

Proceedings relating to the preparation of a Subdivided Standard Yard, and to the new Comparing Microscopic Apparatus for Standard Measures of Length, &c.

I.—*Extract of Minute of Proceedings at the Standards Department, on the 15th of June 1866, on the Meeting of the following Members of the late Standards Commission, by appointment of Lord Wrottesley, and in the absence from England of the Astronomer Royal, viz.:—*

Lord Wrottesley;
Sir John Shaw Lefevre;
Professor Graham, Master of the Mint;
General Sabine, President of the Royal Society.

The Commissioners inspected the new comparing apparatus for standard measures of length, Mr. Chaney being also present, and Mr. James Simms, who explained the use of the apparatus to the Commissioners.

Mr. Chisholm stated the several circumstances relating to the comparison and verification of the new line standard yard for the colony of Victoria, being the first instance of the new comparing apparatus having been used for the verification of a standard measure of length. After detailing the results of the several comparisons already made, he called the attention of the Commissioners to the necessity of determining with accuracy the value of a division of the graduated heads of the two micrometer screws before these results could be finally applied to the verification of the Victoria standard yard and other standards. He showed that no sufficient means were at present provided in the Department for this object, and that it would be necessary that a standard measure of length, having a subdivided inch, with sufficiently fine defining lines, should be furnished. He suggested that it would be expedient that a new line standard yard, divided into a half yard and feet, having one foot subdivided into inches, one inch being subdivided into tenths and hundredths, another into halves, quarters, eighths, and sixteenths, and a third inch into thirds and twelfths, should be constructed by Messrs. Troughton and Simms, for the use of the Department. The Commissioners present approved of this suggestion, but they considered it highly advisable that the exact measure of a metre, of a half metre, and of tenths of a metre, should also be marked upon this new standard of length; considering that as a verified kilogramme, the unit of Metric weight actually compared both with the kilogramme des Archives at Paris,* and with the Imperial standard pound in the Exchequer, and the minutest difference stated, is already deposited in the Weights and Measures Department of the Exchequer, a verified metre, as the primary unit of Metric measure, should also be deposited there.

(Signed) H. W. Chisholm,
Exchequer. Chief Clerk.
Approved by Lord Wrottesley.

II.—*Mr. Chisholm's Report on the Completion of the new Comparing Microscopic Apparatus; its first use for verifying a Primary Standard Yard for the Colony of Victoria; exact deviation from Standard stated; its allowance recommended, and to be noted in Indenture of Verification.*

Sir, Exchequer, June 18, 1866.

I beg to report that Messrs. Troughton and Simms have now completed the microscopic apparatus for comparing standard measures of length, as recommended by the Standards Commission, and authorized by the Treasury letter of 25th July 1865, by the addition of a graduated head of 100 divisions to the large screw moving the plan of the horizontal comparing apparatus designed by the Astronomer Royal, and of lamps with appropriate stands for the microscopes; and also by the important addition of a contact apparatus, by means of which end measures of length may be compared with each other, and with line measures, and the minutest differences between them ascertained.

They have also transmitted plans and drawings of the apparatus, with a specification of the various parts and an explanation of their use, and they state, "that, in their opinion, the Exchequer "officers are now furnished with an apparatus sufficient, not only "for verifying the commercial standards of length, but also for "comparing any primary or scientific measures which may be "submitted to them."

The cost of this apparatus, including 7*l.* 10*s.* for the plans and drawings, amounts to 187*l.* 10*s.*, which will be included in the quarterly contingent expenses of the office to be submitted to the Treasury in the usual course.

A difficulty has, however, arisen, which it will be necessary to overcome before the microscopic apparatus can be practically applied to ascertain and specify the exact difference between standard measures of length.

This difference is read off upon the graduated heads of the micrometers, which are about 1½ inch in diameter, and contain 100 divisions for one revolution of the screw. Messrs. Troughton and Simms have not furnished the Exchequer with the exact value of one of these divisions as a measure of standards at the focal distance of the microscope, as they very properly considered that it would be more authoritatively and satisfactorily ascertained and verified by means of the Exchequer standards themselves. This problem has therefore yet to be solved.

It will probably be found necessary hereafter, for the more accurate comparison of standard measures of length for scientific purposes, to determine under the sanction and with the authority of the Standard Commission, the exact value of a division of the micrometer; and for this purpose, as well as for providing and establishing standard measures of length, being subdivisions of the

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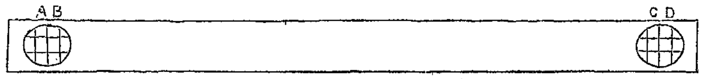
* Professor Miller's Report, pages 936, 946.

Appendix III.—*continued.*

standard yard, that a subdivided standard, including tenths and hundredths of an inch, should be furnished for the use of the Weights and Measures Department.

In the meantime it is imperative that the approximate value of a division of the micrometer should, without delay, be found, in order to compare and verify the Victoria standard yard which has been so long left for verification, and for the completion of which so many and urgent requests have been made. I now proceed to state the details of the several steps that have been taken to find this approximate value by means of the measures of length which the officers of the Weights and Measures Department have had at hand.

It was first attempted to find the value of a division of the micrometer by means of three defining lines cut upon each of the gold studs of the Exchequer standard yard No. 30,* these lines being stated to be distant from each other "about the hundredth "part of an inch." The mean result of forty comparisons of each of the four intervals was as follows:—



A	310·5 divisions.	C	313·5 divisions.
B	324·5 „	D	320 „

Mean - - 317 divisions.

Assuming the mean distance of the four intervals to be exactly 0·01 inch, one division equals 0·0000315. But the expression "about the 100th part of an inch" is too indefinite for this measure to be absolutely relied on.

The next attempt to find the value of a division was from the flat brass scale of a yard subdivided as low as sixteenths of an inch, and which had been furnished to the Exchequer in 1857,* by the Astronomer Royal. After many attempts it was found that the defining lines were too coarsely cut to admit of their being measured with sufficient accuracy by the microscope, but it was clearly shown that the value of a division of the micrometer exceeded 0·00003 inch.

In order to arrive at a more correct measurement and to verify that made from the defining lines of the Exchequer standard No. 30, Messrs. Troughton and Simms lent, for the use of the Department, their most accurate subdivided inch measure, containing both tenths and hundredths of an inch, with a note of the real errors of the subdivisions. The defining lines upon Messrs. Troughton and Simms's scales are cut upon silver, and like the lines upon the gold studs of the Exchequer standards, are so finely cut that it is only in the strongest light that they are visible to the eye of a clear-sighted observer. The mode of observation is to bring one of these lines exactly under the two cobwebs of the microscope at the point where they cross each other (thus ×), and to note the number of the divisions of the micrometer when the line is exactly bisected. To show the care with which it is requisite this should be done and the very minute distances marked by the micrometer, I may state that the breadth of the finest of these lines is nearly ten divisions, and that the breadth of an ordinary human hair is about 100 divisions.

Two of the inches on Messrs. Troughton and Simms's scale are divided into tenths, and three of these tenths into hundredths. Each of these subdivisions was carefully measured by myself, Mr. Chaney, and D. Porter, the mechanic employed in the Department. After allowing for the real errors of the subdivisions, the mean result was as follows:—

Mr. Chisholm	1 division equal to	0·0000317
Mr. Chaney	„ „	0·0000316
D. Porter	„ „	0·0000318

The mean being 0·0000317 inch.

The result agreed sufficiently with that obtained from the defining lines of the Exchequer standard to justify the approximate value of one division of the micrometer to be taken as equal 0·00003 inch. With more practice and greater experience a more exact measurement may hereafter be determined.

The value of one division of the micrometer used by the late Mr. Sheepshanks in the construction of the Imperial standard yard was 100th of the revolution of the screw or 0·00003587 inch.

Assuming, therefore, the value of a division of the micrometer to be 0·00003 inch, I will now state the result ot the comparison of the Victoria standard. This is engraved "Primary standard yard, "Victoria, 1864, 60° Fahrenheit." This temperature denotes that at 60° it is exactly squal to the Imperial standard, which is the legal measure of a yard at 62°. It has been compared with the Exchequer line standard No. 30, which has a standard temperature of 61°·66. By the mean of 15 comparisons taken with each of the two microscopes, the Victoria standard was found to be in excess of the Exchequer standard 55 divisions of the micrometer, equal 0·00165 inch. As the same result was found from each of the microscopes, it may here be remarked in passing that it shows the value of one division of each of the micrometers to be equal, which would necessarily occur with screws having equal threads and with equal focal distances of the microscopes. The Exchequer standard No. 30 being in excess of the Imperial standard 0°·34 of standard temperature, or 0·000116 inch, the excess of the Victoria standard over the Imperial standard will thus be 0·001766 inch, showing it to be equal to the standard when it is at a temperature of 56°·82 Fahrenheit, as the thermometric expansion of 36 inches of a bronze bar such as that of which each of these standards is composed, is 0·000341 inch for 1° Fahrenheit.

The allowance of error recommended by the Standard Commission in their Report of 1841 † for measures of length, is $\frac{1}{12000}$ of the whole. This allowance for a standard yard is equal to 0·003 inch, and gives a range of standard temperature of about 10° Fahrenheit.

This deviation of the Victoria standard being therefore within the allowance thus recommended, I have to report the comparison and verification of this standard as completed, and that when the standard temperature marked upon it be corrected to 57° as the nearest approximate temperature, it may be duly stamped and passed as verified with an indenture of verification.

But as no regulation has yet been established for allowing the smallest deviation from the standard, I have to submit to you the expediency of obtaining the sanction and authority of the Lords Commissioners of Her Majesty's Treasury, before finally passing this standard as duly verified.

I am, &c.
(Signed) H. W. Chisholm,
Chief Clerk.

The Comptroller-General
of the Exchequer.

III.— *Comptroller-General to Treasury, transmitting the foregoing Report.*

My Lords, Exchequer, June 18, 1866.

I beg to transmit to your Lordships the inclosed Report of Mr. Chisholm upon the comparison and verification of the primary standard yard for the Colony of Victoria.

It has become a matter of urgency to pass this standard, the verification of which has for so long a period been unavoidably delayed. This, however, being the first instance of the comparison of a line standard with the new apparatus, by which the smallest difference from the standard can be ascertained and specified, and no regulation having yet been established for allowing for the smallest deviation, I am compelled to ask for your Lordships' directions.

As the Victoria standard appears to be considerably within the allowance for deviation ($\frac{1}{12000}$ of the whole) recommended by the Standards Commission, I propose, should your Lordships concur, to stamp and pass it with an indenture of verification upon standard temperature marked upon it being altered to 57° Fahrenheit.

I have, &c.
(Signed) Wm. Dunbar,
Comptroller-General.

The Lords Commissioners of Her
Majesty's Treasury.

IV.—*Treasury to Comptroller-General, sanctioning allowance of Deviation in the Victoria Standard Yard, to be noted in the Indenture of Verification.*

Sir, Treasury Chambers, June 22, 1866.

In reply to your letter of the 8th instant, I am commanded by the Lords Commissioners of Her Majesty's Treasury to state that, as the result of the comparison of the standard yard for the Colony of Victoria with the Exchequer line standard, exhibits an amount of deviation from the Imperial standard within the allowance recommended by the Commissioners in their Report of 1841, their Lordships are of opinion that you may properly cause the same to be stamped and passed with the usual indenture of verification, the standard temperature marked upon it being, for the reason explained in Mr. Chisholm's Report, corrected to 57° Fahrenheit.

I am to add that, in conformity with the recommendation contained in your Report of the 8th March, my Lords consider that the amount of actual deviation should be stated in the indenture of verification.

I am, &c.
(Signed) G. A. Hamilton.

The Comptroller-General
of the Exchequer.

V.—*Warden of the Standards to Board of Trade, reporting Astronomer Royal's approval of Minute of June* 15, 1866 (*I.*)*; consequent addition required to new comparing apparatus; immediate commencement of Verification of Official Standards, and assistance of one or more of the principal Makers of Standards.*

Sir, Standards Department, September 14, 1866.

I beg to report to you, for the information of the Board of Trade, that the Astronomer Royal, the Chairman of the late Standards Committee, has attended here for the purpose of discussing with me the steps necessary to be taken with reference to the standards, and the object of the proposed Commission.

I laid before him the following extract of a Minute of the proceedings at a meeting of some of the other members of the late Standards Committee, who met, by appointment of Lord Wrottesley (in the absence of the Astronomer Royal), at this office on the 15th June last. (See No. I.)

The Astronomer Royal approves of this proposal, and will communicate with Messrs. Troughton and Simms with the view of carrying it out, as well as of having some additions made to the new comparing apparatus to adapt it to this new standard. I do not anticipate that the expense of the new subdivided standard of length, including any alterations which may be required in the microscopical comparing apparatus, will exceed 200*l.*

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* Report on Exchequer Standards, 1863, page 29.
† Ibid., page 21.

* Astronomer Royal's Report, 1858, page 79.

Appendix III.—*continued.*

The Astronomer Royal agreed with me that proceedings should at once be commenced to ascertain the exact condition of the official standards by the officers of the Department, assisted by one or more of the principal manufacturers of weights and measures, in pursuance of the Treasury Minute, of the 26th February last. These manufacturers will, of course, expect to be paid for their services.

I have therefore to request that you will obtain the sanction of the Treasury to the expenditure that will be incurred for these objects, in order that they may be carried out by the time that the proposed Commission meets.

I am, &c.
The Secretary to the Board of Trade. (Signed) H. W. Chisholm, Warden of the Standards.

VI.—*Treasury to Board of Trade, sanctioning the consequent expense to be incurred.*

Sir, Treasury, October 25, 1866.

I have laid before the Lords Commissioners of Her Majesty's Treasury your letter of the 28th ultimo, submitting copy of a Report from Mr. Chisholm, on the subject of certain instruments required for the Weights and Measures Department of the Board of Trade, and as to the expenses of the employment of experts to assist in ascertaining the exact condition of the official standards.

I am desired by their Lordships to state, in reply, and for the information of the Lords of the Committee of Privy Council for Trade, that my Lords will be prepared to direct the issue of such sum, not exceeding 200*l.*, as may be required for purchasing the proposed new standard of length marked in subdivision, and for altering the new comparing apparatus as recommended by Mr. Chisholm.

My Lords will also provide for the remuneration of the experts whose attendance and aid may be required for carrying out the examination of the official standards; but before any arrangement is finally made with these persons,* I am to request that it may be submitted for their Lordships' sanction, and that the Lords of the Committee will bear in mind the necessity of confining the expenditure under this head to what may strictly be necessary for enabling the officers of the Department to perform the duty in question.

I am, &c.
The Secretary to the Board of Trade. (Signed) G. A. Hamilton.

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* The object of obtaining the assistance of some of the principal manufacturers of weights and measures in the examination of the official standards was to carry out the intention of the Treasury Minute of February 26, 1866, "That no time should be lost in ascertaining the "exact condition of the Exchequer standards, and in making such arrangements as shall be thought expedient for their complete re-adjustment or renewal." These arrangements were proposed to be made under the supervision of the Standards Commission. As, however, the appointment of the Standards Commission has been so long delayed, it will not now be found necessary to engage the assistance of such manufacturers, the examination of the official standards having been proceeded with by the officers of the department, and that of the weights having been already completed, and reported to the Board of Trade on the 18th of February last. A full statement of the process of comparison of the official standard weights and the results will be shown in a subsequent Paper.

H. W. Chisholm, Warden.
Standards Department, March 8, 1867.

APPENDIX IV.

Paper Delivered by the Warden of the Standards.—Actual Comparison of Board of Trade Standards of Avoirdupois and Troy Weight.

Contents.

Page

When comparisons begun - - - - - 26
Number of comparisons made in each case - - „
Record of process - - - - - - - „

Comparison of Standard Weights:

Mode of comparison - - - - - - „

Avoirdupois Weights:

First comparison of the two official standard lbs. of 1855 with each other - - - - - 27
Process shown at length - - - - - „
Its result - - - - - - - „
Comparison of Captain Kater's lb. of 1824 with new standard - - - - - - -
Comparison of official working lb. with Captain Kater's lb. of 1824 - - - - - „
Summary of comparisons of official standards of avoirdupois weight with each other - - „
Exact relation of these avoirdupois standards to the Imperial standard - - - - - - 28
Proof of accuracy of comparison of avoirdupois standards - - - - - - - „
Their present condition - - - - - „

Page

Troy Weights:

Present condition of troy weights - - - 29
Their comparison based on 10 oz. and 2 oz. bullion standard weights - - - - - - „
Comparison of working standard troy lb. with Captain Kater's troy lb. No. 5 of 1824 - - - „
Comparison of Captain Kater's troy lb. No. 5 with the Imperial standard - - - - - „
Summary of comparisons of official standards of troy weight with each other - - - - „
Exact relation of these troy standards to the Imperial standard - - - - - - - „
Ease in reducing the comparison of standards when divided on a binary scale - - - - 30
And also on the duodecimal scale of division - - „
As compared with those divided on a decimal scale - „
Proof of accuracy of comparison of troy standards - „

When comparisons begun.

The actual comparison of the official standards with the Imperial standards of weight and of length, and with each other, was begun by Mr. Chaney on the 8th January 1867, under the direction of the Warden of the Standards. These comparisons were made according to the process already described in Appendix III.; the necessary books containing the tabular forms for noting and recording the process and its results having been procured.

Number of comparisons made in each case.

In order to determine the excess or deficiency of any standard, when compared with any other or with more than one standard, it was considered to be sufficient, as proposed at page 19, Appendix III., to take the mean of ten comparisons made on two successive days.

Record of process.

Full details of each separate comparison are noted in the official books prepared for the purpose, and which are open to the inspection of the Commissioners. The Warden of the Standards has carefully checked the several calculations and results. It may be requisite here to show only the practical results of the comparisons of the several standards, and more particularly the exact condition of each of the official standards used for verifying the local standards, in their relation to the Imperial standards of weight and of length; these official standards, although secondary to the two Imperial standards, being the primary instruments for regulating all the national weights and measures.

Comparison of Standard Weights.

Mode of comparison.

In order to assist the eye in more correctly dividing one division of the balance index into tenths, it was found necessary to make the observations through a small aperture in a paper screen, interposed between the eye of the observer and the index scale; the head of the observer being kept in the same position during each comparison of standards. The screen being placed between the observer and the balance was also found useful in maintaining uniformity of temperature. The value of one division of the scale of the balance was determined for each comparison, by taking the mean of five or six observations made on the same day.

Appendix IV.—*continued.*

Avoirdupois Weights.

First comparison of the two official standard pounds of 1855 with each other.

The first instance of the comparison of standards which has been made and recorded was that of the two official gilt gun-metal copies of the Imperial standard pound with each other; twenty comparisons being made on two successive days, or double the ordinary number.

These two standards are mentioned at page 19, Appendix III., No. 31 of 1855 having been previously determined to be 0·00080 grain heavier than the standard, and No. 34, 0·00089 grain lighter. It would appear, therefore, that when tested by Professor Miller, No. 31 was 0·00169 grain heavier than No. 34.

Process shown at length.

As an illustration of the *modus operandi*, the notation of the process of comparing these two standards may be here given at length, viz.:—

COMPARISON of the two official copies of the Imperial Standard Pound, No. 34 of 1855, with No. 31 of 1855.
(Comp. Book, p. 1.)

Date of Comparison.	Compared Standard.	Comparing Standard.	Divisions of Index Scale.								Result in Divisions.	Value of one Division in Grains. (*See* below).	Result in Grains.
			Compared Standard.				Comparing Standard.						
			Highest.	Lowest.	Sum.	Mean resting point.	Highest.	Lowest.	Sum.	Mean resting point.			
Jan. 8, 1867.	B. T. Gilt Gun-metal lb. No. 34.	B. T. Gilt Gun-metal lb. No. 31.	10·3	8·5	18·8	9·3225	10·9	8·3	19·2	9·545	Compared +0·11125 div. =comparing.	0·01512	Compared +0·00168 gr. =comparing.
			10·2	8·6	18·8		10·8	8·4	19·2				
			10·1	8·6	18·7		10·7	8·5	19·2				
			10·1	8·6	18·7		11·3	7·9	19·2				
			10·	8·8	18·8		11·1	8·	19·1				
			10·9	7·8	18·7		11·	8·	19·				
			10·8	7·9	18·7		10·9	8·2	19·1				
			10·	8·6	18·6		10·9	8·2	19·1				
			10·	8·6	18·6		10·9	8·2	19·1				
			10·7	8·	18·7		11·2	7·3	18·5				
Jan. 9, 1867.			10·6	8·1	18·7		12·	7·3	19·3				
			10·6	8·1	18·7		11·9	7·2	19·1				
			10·6	8·2	18·8		12·8	6·5	19·3				
			11·8	6·8	18·6		12·6	6·8	19·4				
			11·5	6·8	18·3		12·5	6·8	19·3				
			11·6	6·8	18·4		10·9	8·	18·9				
			11·5	7·1	18·6		10·8	8·2	19·				
			11·5	7·1	18·6		10·7	8·	18·7				
			11·5	7·1	18·6		10·8	8·3	19·1				
			10·	8·5	18·5		10·8	8·2	19·				
Total of 20 comparisons			214·3	158·6	40) 372·9		225·5	156·3	40) 381·8		9·545 9·3225 2)0·2225 0·11125=Diff. in div.	0·11125 0·01512 22250 11125 55625 11125 0·0016821000=Diff. in gr.	
Mean temperature 49°. Barometer corrected for temperature 29·03 inch.					9·3225				9·545				

To find the Value of 1 *Division.*

Balance Weight, 0·02 grain (the exact weight being 0·01932 grain) added to Compared Standard, 1 lb., No. 34, and weighed against Comparing Standard.

(Comp. Book, p. 1.)

Date of Comparison.	Divisions of Index Scale.				Result in Divisions.	Value of one Division, in Grains.
	Highest.	Lowest.	Sum.	Mean resting point.		
1867. January 9	12·4	9·	21·4	10·6	1·2775	0·01512
	12·1	9·1	21·2			
	11·1	10·1	21·2			
	11·	10·	21·			
	12·1	9·1	21·2			
Total	58·7	47·3	10)106 10·6			

Compared standard { + 0·01932 gr. = 10·6
= 9·3225

Difference in divisions 1·2775) 0·019320 (0·01512 gr.
12775
65450
63875
15750
12775
29750

Its result.

The result of this comparison of the two standard pounds is that No. 31 appears now to be 0·00168 grain heavier than No. 34. This result agrees remarkably with that of Professor Miller's comparison in 1855, before mentioned.

Mr. Chaney's first comparison of the same two standards, made on 29th September last (see Appendix III., page 19), was not so carefully made, being merely an experiment for illustration, and it was made before the balances had been put in perfect order. It should be observed that Mr. Chaney has found his own weighings generally to agree more nearly with each other when the atmosphere was *dry* and undisturbed.

Comparison of Captain Kater's lb. of 1824, with new standard.

A similar comparison of the 1 lb. brass primary avoirdupois pound No. 1, made by Captain Kater in 1824, and deposited at the Treasury until 1865 (see Appendix III., page 20), has now been made with the gilt gun-metal 1 lb., No. 34 of 1855, and shows Captain Kater's pound No. 1 to be 0·05624 grain heavier than the new standard.

Comparison of official working lb. with Captain Kater's lb.

Upon comparing the official standard avoirdupois pound, which has been in use since 1825, with Captain Kater's primary pound No. 1, which has never been used, and of which the official standard was a copy, the latter was found, on the mean of five comparisons, to be 0·90177 grain lighter. This, therefore, may be assumed to be the amount of deterioration of this standard weight, from wear and tear, in forty-one years.

It would appear, as a result of these two comparisons, that the working avoirdupois pound is now 0·84553 grain lighter than the new standard. It will be seen that this result differs but little from that of the direct comparison of the working avoirdupois pound of 1824 with an official copy of the new standard pound.

But the most important comparisons for practical purposes are those of the official standards used for the verification of all the local standard weights of the kingdom.

Summary of comparisons of official standards with each other.

The following summary shows the results of the comparisons of the several official standards of avoirdupois weight with each other. In some cases it was found necessary to use one or more of the small balance weights, in order to bring the difference between the two weighted pans within the range of the index scale. It will be seen that the basis of the comparison of all these standards is the gilt gun-metal 1 lb. standard weight, No. 31, of 1855.

Appendix IV.—*continued.*

Summary of Comparisons of Standard Avoirdupois Weights.

When the weight only is specified it signifies the official Working Standard.

C = its counterpoise.
b = the balance grain weights.

	Compared Standards.	Comparing Standards.	Excess or Deficiency of Compared Standards in relation to the Comparing Standards.
1 lb. & multiples.	1 lb. + *b* = 0·99511 gr. - -	≏ 1 lb. No. 31 of 1855 + *b* = 0·09951 gr. - -	+ 0·04471 gr.
	2 „ - - - - -	≏ Ditto and No. 34 - - - - -	− 0·40425 „
	4 „ - - - - -	≏ 2 lb. and the two preceding - - - -	− 0·17391 „
	7 „ - - - - -	≏ 4 lb., 1 lb., and ditto - - - - -	+ 0·79380 „
	14 „ - - - - -	≏ 7 lb., 4 lb., 2 lb., and 1 lb. - - - -	+ 1·41337 „
	28 „ - - - - -	≏ 14 lb., and the four preceding - - - -	+ 2·13945 „
	56 „ - - - - -	≏ 28 lb., and the five preceding - - - -	− 6·95271 „
Parts of 1 lb.	C 8 oz. - - - - -	≏ 8 oz. - - - - - - -	+ 0·02361 „
	8 oz. + C + *b* = 0·76317 gr. - -	≏ 1 lb., No. 31 of 1855 - - - - - -	+ 0·03375 „
	C 4 oz. - - - -	≏ 4 oz. - - - - - - -	+ 0·00446 „
	4 oz. + C + *b* = 0·09951 gr. - -	≏ 8 oz. - - - - - - -	+ 0·00253 „
	C 2 oz. - - - - -	≏ 2 oz. - - - - - - -	+ 0·01807 „
	2 oz. + C - - - - -	≏ 4 oz. - - - - - - -	− 0·00520 „
	C 1 oz. - - - - -	≏ 1 oz. - - - - - - -	− 0·03024 „
	1 oz. + C + *b* = 0·19902 gr. - -	≏ 2 oz. - - - - - - -	+ 0·04126 „
	C 8 dr. - - - - -	≏ 8 dr. - - - - - - -	+ 0·00281 „
	8 dr. + C + *b* = 0·09951 gr. - -	≏ 1 oz. - - - - - - -	− 0·00109 „
	C 4 dr. - - - - -	≏ 4 dr. - - - - - - -	+ 0·00623 „
	4 dr. + C + *b* = 0·07933 gr. - -	≏ 8 dr. - - - - - - -	+ 0·00001 „
	C 2 dr. - - - - -	≏ 2 dr. - - - - - - -	− 0·00182 „
	2 dr. and C - - - -	≏ 4 dr. - - - - - - -	+ 0·00666 „
	C 1 dr. - - - - -	≏ 1 dr. - - - - - - -	+ 0·00154 „
	1 dr. + C + *b* = 0·02883 gr. - -	≏ 2 dr. - - - - - - -	+ 0·00595 „
	C ½ dr. - - - - -	≏ ½ dr. - - - - - - -	+ 0·00509 „
	½ dr. + C - - - - -	≏ 1 dr. - - - - - - -	+ 0·00979 „

Exact relation of the official standards to the Imperial standard.

From these results the exact condition of the several official standards of avoirdupois weight, in relation to the Imperial Standard, has been determined as follows, the process being recorded in the official books :—

Exact Relation of Official Standards of Avoirdupois Weight to the Imperial Standard.

Standard	56 lb. =	391,988·14352 gr.	or	11·85648 gr.	less than	Imperial standard.
„	28 lb. =	195,998·61784 „	or	1·38216 „	„	„
„	14 lb. =	97,998·94588 „	or	1·05412 „	„	„
„	7 lb. =	48,999·36528 „	or	0·63472 „	„	„
„	4 lb. =	27,999·42166 „	or	0·57834 „	„	„
„	2 lb. =	13,999·59566 „	or	0·40434 „	„	„
„	1 lb. =	6,999·14991 „	or	0·85009 „	„	„
„	8 oz. =	3,499·62388 „	or	0·37612 „	„	„
„	4 oz. =	1,749·76122 „	or	0·23878 „	„	„
„	2 oz. =	874·84446 „	or	0·15554 „	„	„
„	1 oz. =	437·35847 „	or	0·14153 „	„	„
„	8 dr. =	218·62753 „	or	0·12247 „	„	„
„	4 dr. =	109·27099 „	or	0·10401 „	„	„
„	2 dr. =	54·63973 „	or	0·04777 „	„	„
„	1 dr. =	27·30755 „	or	0·03620 „	„	„
„	½ dr. =	13·65612 „	or	0·01575 „	„	„

The greatest amount of error is naturally to be found in the heaviest weight, the 56 lb. But it amounts to no more than one 33,000th part of the whole. The error of the 28 lb. weight is proportionally much less. The greater error of the 56 lb. weight may to some extent have been caused by the practice of lifting it into the pan of the balance by means of a mahogany lever. All the other standard weights are placed in the pans by hand. The 56 lb. has necessarily been subjected to greater friction.

The above-stated errors of the standards, from 1 lb. to 28 lb. inclusive, have been proved in the following mode :—

The 28 lb. weight has been shown to be 1·38216 grain less than the imperial standards; and the total errors of the standard weights, from 1 to 14 lbs. inclusive (1+2+4+7+14=28), amount to 3·52161 grains in deficiency. The difference of error was thus found to be 2·13945 grains. The five standards were placed in one of the pans of balance No. 1, together with small balance weights, amouting as nearly as possible to 2·13945 grains, and in the other pan the 28 lb. standard was placed. The balance was then found to be equipoised.

Proof of accuracy of comparison of avoirdupois standards.

It will be satisfactory also to state that the accuracy of these comparisons and calculations of the actual weight of the smaller avoirdupois standards has, to a great extent, been proved by the following further comparison of the 1 dram standard with equivalent bullion standards, according to their weight, as determined by Professor Miller (See App. III., p. 23) :—

Compared Standards.		Comparing Standards.	
	grain.		grain.
1 dram avoirdupois =	27·30755	Bullion weight 0·05 oz.=	23·99992
Balance weight 0·1 gr. =	0·09951	„ 0·005 oz.=	2·39923
		„ 0·002 oz.=	0·96018
		Balance weight 0·02 gr.=	0·02012
		„ 0·002 gr.=	0·01932
	27·40706		27·39877
Deduct probable error of observations being in excess - - -	0·00222	Add ascertained mean difference less than compared standards	0·00607
	27·40484		27·40484

The result of the comparison of all the standard avoirdupois weights from 1 lb. to 1 dram is thus shown to be so far correct that the true standard weight of the 1 dram, as deduced from all these comparisons, is ascertained within 0·00222 gr., or about half of one division of the index scale of the balance, the value of one division having been found to be 0·00423 gr.

Their present condition.

These official standards of avoirdupois weight are all made of hard yellow brass, and of spherical shape. They

Appendix IV.—*continued.*

are discoloured by oxidation, the bottom of several weights being slightly scratched. All are in good condition, considering that they have been constantly used for comparisons in the Department for 42 years.

Troy Weights.

Present condition of troy weights.

The official standards of troy weight, from 1 lb. to 1 dwt. inclusive, are also made of hard yellow brass, and are spherical in shape. They are slightly oxidized having been in use in the Department, like the avoirdupois weights, since 1825, though not so frequently required. The grain weights are of platinum, flat shape.

Their comparison based on 10 oz. and 2 oz. bullion weights.

The comparison of the troy standard weights has been based on that of the troy pound with the two gilt gun-metal bullion standards of 10 oz. and 2 oz. The true weight of these bullion standards was carefully ascertained by Professor Miller in 1855 (See Appendix III., page 22), and found to be as follows :—

10 oz.	0·00042 too heavy.
2 oz.	0·00053 too light.
12 oz.	0·00011 too light.

For the present, it may be assumed that these bullion standards have not sensibly varied in weight since 1855, The verification of the bullion standards is necessarily deferred until the receipt of the verified auxiliary platinum weights, amounting to 1,240 grains, or the difference between the troy pound and the imperial standard avoirdupois pound. These auxiliary weights are now at Greenwich, in the custody of the Astronomer Royal, and are to be transferred to the Standards Department.

Comparison of official standard troy lb., with Captain Kater's troy lb. No. 5 of 1824.

Upon comparing the official troy standard pound, which has been used in the Department since 1825 for the comparison of local standards, with the troy standard pound No. 5, constituted as a standard of reference by Captain Kater, and which has only been once used, the official troy pound was found to be in excess 0·10483 grain. This may therefore be taken to be the relative amount of deterioration in 42 years of the Exchequer official troy pound, as compared with that of the troy pound No. 5, both standards having gained in weight by oxidation.

Professor Miller's "Construction of New Standards," p. 772.

Captain Kater's standard pound No. 5 was most carefully compared by him in 1824, with the imperial standard in the custody of the clerk of the House of Commons, who confided it to Captain Kater's care for that purpose, and was found to be 0·001 grain in excess of the standard. It was also compared in 1844, by Professor Miller, with the known weight of the lost standard, as ascertained by the two platinum copies, which were considered to have undergone no sensible change since they were compared with the standard in 1829, and was then found to be 0·0099 grain in excess. The increase in its weight in the course of 20 years, up to 1844, was therefore found to be 0·0089 grain, in consequence, probably, of the oxidation of its surface.

Comparison of Captain Kater's troy lb. No. 5 of 1824, with the Imperial standard.

Upon comparing the official troy pound with the two bullion standards 10 oz. and 2 oz., it was found to be in excess 0·13182 grain. As the two bullion weights together were found in 1855 to be 0·00011 grain too light, the working troy pound is now found to be 0·13171 grain in excess of the true standard weight. In this result it is assumed, as before stated, that the two bullion standards have not sensibly altered since 1855.

It would appear, therefore, that deducting 0·10483 grain, the excess of the official troy pound over Captain Kater's pound No. 5, this last standard is now 0·02688 grain in excess of its true weight in terms of the present imperial standard, and that whilst the pound No. 5 increased in weight 0·0089 grain in 20 years, from 1824 to 1844, it has increased 0·01698 grain in the 23 years from 1844 to 1867.

It should, however, be observed, that to the stated mean results of the observations from which Professor Miller deduced the increase of weight of Captain Kater's pound in 1844, this note is appended :—" The results appear to " be considerably in error." It can, indeed, hardly be the case that the increase of weight of this standard from oxidation should have been twice as much in the latter 23 years as in the former 20 years ; and especially when it is considered that Professor Miller has stated his opinion, that the imperial standard pound of 1758, when examined in 1829, " was preserved from further change by the coat " of oxide already formed," since it was compared in 1824.

P. 772.

The following table shows the results of the comparison of the several troy standard weights with each other :—

Summary of comparison of official standards of troy weight.

Summary of Comparisons of Standard Troy Weights, and their Counterpoises.

Compared Standards.	Comparing Standards.	Excess or Deficiency of Compared Standards in relation to the Comparing Standards.
1 lb.	10 oz. and 2 oz. bullion weights + *b* = 0·09951 gr.	+ 0·03231 gr.
C 6 oz.	6 oz.	− 0·00416 „
6 oz. + C + *b* = 0·19902 gr.	1 lb.	+ 0·05165 „
C 3 oz.	3 oz.	+ 0·04836 „
3 oz. + C	6 oz.	+ 0·05537 „
No. 1 C 2 oz.	2 oz.	− 0·02370 „
No. 2 C 2 oz.	2 oz.	− 0·00073 „
2 oz. + No. 1 C + No. 2 C	6 oz.	− 0·02432 „
C 1 oz.	1 oz.	− 0·01711 „
1 oz. + C.	2 oz.	− 0·02070 „
C 10 dwt.	10 dwt.	+ 0·00325 „
10 dwt. + C	1 oz.	− 0·00721 „
C 5 dwt.	5 dwt.	− 0·03561 „
5 dwt. + C	10 dwt.	− 0·03236 „
C 3 dwt.	3 dwt.	− 0·00358 „
No. 1 C 2 dwt.	2 dwt.	+ 0·00830 „
No. 2 C 2 dwt.	2 dwt.	− 0·00499 „
3 dwt. + C	2 dwt. + No. 1 C + No. 2 C	− 0·00656 „
3 dwt. + 2 dwt.	5 dwt.	+ 0·00278 „
2 dwt. + 1 dwt.	3 dwt.	− 0·00197 „
C 1 dwt.	1 dwt.	− 0·00686 „
1 dwt. + C	2 dwt.	− 0·00189 „
C 12 gr.	12 gr.	Equal.
12 gr. + C	1 dwt.	− 0·00112 „
C 6 gr.	6 gr.	+ 0·00275 „
6 gr. + C	12 gr.	− 0·00309 „
C 3 gr.	3 gr.	+ 0·00336 „
3 gr. + C	6 gr.	− 0·00131 „
No. 1 C 2 gr.	2 gr.	+ 0·00376 „
No. 2 C 2 gr.	2 gr.	+ 0·00351 „
2 gr. + No. 1 C + No. 2 C	6 gr.	− 0·00036 „
C 1 gr.	1 gr.	− 0·00014 „
1 gr. + C.	2 gr.	+ 0·00263 „

Appendix IV.—*continued.*

Exact tion of troy st nrds to Imperi standa

The exact weight of the several troy standards, in terms of the Imperial standard, and the actual excess or deficiency of each weight in relation to the standard, would appear, therefore, to be as follows :—

Relation of Official Standards of Troy Weight to the Imperial Standard.

Standard	1 troy lb.	= 5760·13171 gr.	or 0·13171 gr.	heavier	than Imperial standard.
,,	6 oz.	= 2879·99425 ,,	or 0·00575 ,,	lighter	,,
,,	3 oz.	= 1440·00063 ,,	or 0·00063 ,,	heavier	,,
,,	2 oz.	= 959·99812 ,,	or 0·00188 ,,	lighter	,,
,,	1 oz.	= 479·99727 ,,	or 0·00273 ,,	,,	,,
,,	10 dwt.	= 239·99340 ,,	or 0·00660 ,,	,,	,,
,,	5 dwt.	= 119·99833 ,,	or 0·00167 ,,	,,	,,
,,	3 dwt.	= 71·99754 ,,	or 0·00246 ,,	,,	,,
,,	2 dwt.	= 47·99801 ,,	or 0·00199 ,,	,,	,,
,,	1 dwt.	= 24·00150 ,,	or 0·00150 ,,	heavier	,,
,,	12 gr.	= 12·00019 ,,	or 0·00019 ,,	,,	,,
,,	6 gr.	= 5·99722 ,,	or 0·00278 ,,	lighter	,,
,,	3 gr.	= 2·99627 ,,	or 0·00373 ,,	,,	,,
,,	2 gr.	= 1·99653 ,,	or 0·00347 ,,	,,	,,
,,	1 gr.	= 0·99965 ,,	or 0·00035 ,,	,,	,,

Facility of reducing the comparisons of standards when divided on a binary scale;

In ascertaining these relations from the actual comparisons of the standards with each other, the calculations have been very simple, when the several standards diminish in weight, according to a binary scale, and each standard and its counterpoise together represent the weight of the next larger standard, the exact weight of which has previously been determined.

Thus the 1 lb. troy standard, or 12 oz. = 5760·13171 gr.

Let x represent the 6 oz. standard, and x^1 its counterpoise—

$$\begin{aligned} \text{Then } x + x^1 &= 5760{\cdot}13171 - 0{\cdot}14737 \\ x - x^1 &= \quad ,, \quad + 0{\cdot}00416 \end{aligned}$$

$$\text{Whence } 2x = \quad ,, \quad - 0{\cdot}14321 \text{ or } 5759{\cdot}99850$$

$$\therefore \text{6 oz. standard, or } x = 2879{\cdot}99425 \text{ gr.}$$

And also on a duodecimal scale of division;

Nor is the calculation much more difficult in the duodecimal scale of division, in consequence of the provision that has been made of a second counterpoise to each of the standards of 2 oz., 2 dwt., and 2 gr.; thus,—

Let x = the 2 oz. standard, and x^1 and x^2 its two counterpoises—

$$\begin{aligned} \text{The 6 oz. standard} &= 2879{\cdot}99425 \text{ gr.} \\ x + x^1 + x^2 &= \quad ,, \quad - 0{\cdot}02432 \\ x &= x^1 + 0{\cdot}02370 \\ x &= x^2 + 0{\cdot}00073 \end{aligned}$$

$$\text{Whence } 3x = 2879{\cdot}99425 \text{ gr.} + 0{\cdot}00011, \text{ or } 2879{\cdot}99436 \text{ gr.}$$

$$\therefore \text{2 oz. standard, or } x = 959{\cdot}99812 \text{ gr.}$$

As compared with those divided on a decimal scale.

But where both the binary scale and the duodecimal scale of division are departed from, and the decimal scale is introduced, the calculation is much longer and more involved, as may be seen from the following instance of determining the actual weights of the standards of 3 dwt. and 2 dwt., from a comparison of these two standards with the 5 dwt. standard, the actual weight of which had been already ascertained. In order to ascertain the relative weight of these two standards, it has been found necessary to learn also the relative weight of the 1 dwt. standard and its counterpoise, and to make use of these weights in the calculation.

Thus,

5 dwt. standard = 119·99833 gr.

Standard 3 dwt. + 2 dwt. = 5 dwt. standard − 0·00278 gr.

Therefore,

Standards 3 dwt. + 2 dwt. = 119·99555 gr.

Required actual weight of each of the two standards 3 dwt. and 2 dwt.

Let x represent 3 dwt. standard; y 2 dwt.; z 1 dwt.; and z^1 its counterpoise. It has been ascertained that

$$\begin{aligned} x + y &= 119{\cdot}99555 \text{ gr. (1)} \\ y + z &= x + 0{\cdot}00197 \text{ gr. (2)} \\ z + z^1 &= y - 0{\cdot}00189 \text{ gr. (3)} \\ z - z^1 &= 0{\cdot}00686 \text{ gr. (4)} \end{aligned}$$

Adding (3) to (4),

$$2z = y + 0{\cdot}00497$$

$$\therefore z = \frac{y + 0{\cdot}00497}{2}$$

Substituting value of z in (2),

$$y + \frac{y + 0{\cdot}00497}{2} = x + 0{\cdot}00197$$

$$3y + 0{\cdot}00497 = 2x + 0{\cdot}00394$$

$$\therefore \quad y = \frac{2x - 0{\cdot}00103}{3}$$

Substituting value of y in (1),

$$x + \frac{2x - 0{\cdot}00103}{3} = 119{\cdot}99555$$

$$\begin{aligned} 5x - 0{\cdot}00103 &= 359{\cdot}98665 \\ 5x &= 359{\cdot}98768 \\ \therefore \quad x &= 71{\cdot}99754 \text{ gr., actual weight of 3 dwt. standard.} \end{aligned}$$

From (1),

$y = 119{\cdot}99555 - x = 47{\cdot}99801$ gr., actual weight of 2 dwt. standard.

From (2),

$z = x - y + 0{\cdot}00197 = 23{\cdot}99953 + 0{\cdot}00197 = 24{\cdot}00150$ gr., actual weight of 1 dwt. standard.

This is an instance of the advantage of the binary scale of division of weights and measures over both the duodecimal and the decimal scale, so far as regards simplicity and ease of calculation, as well as of the duodecimal over the decimal scale of division.

Proo curac comp of trc stanc

The very near approach to accuracy of all these comparisons and calculations of the troy standards has been proved by the following separate comparisons of the 12 gr. and 1 gr. standards :

Comparing Standard.		Compared Standard.	
	gr.		gr.
Troy 12 gr. - - -	=12·00019	Bullion weight 0·025 oz.	=11·99993
Add probable error of observations being in deficiency - - -	0·00027	Add ascertained mean difference less than comparing standard	0·00053
	12·00046		12·00046

As the value of one division of the index scale was found in the comparison to be 0·00372 gr., it will be seen that the probable error does not amount to one-tenth of a division, the smallest difference that can be observed.

The same satisfactory result was found in comparing the troy 1 gr. standard with the balance decimal 2 grain weight, No. 7 :

Comparing Standard.		Compared Standard.	
	gr.		gr.
Troy 1 gr. - - -	=0·99965	Balance 1 gr. No. 7 -	=0·99511
Deduct probable error of observation being in excess - - -	0·00041	Add ascertained mean difference less than comparing standard -	0·00413
	0·99924		0·99924

The value of one division of the index scale being, in this case, found to be 0·00406 gr., the true standard weight of the troy 1 gr. standard, as deduced from the comparisons of all the several troy standards, from 1 lb. down to 1 gr., has been ascertained within 0·00041 gr., or one-tenth of a division of the index scale of the finest of the official balances.

The actual comparison of the official standard bullion weights, and the measures of capacity and of length will be shown in subsequent Papers.

H. W. CHISHOLM,
Warden.

Standards Department,
April 24, 1867.

APPENDIX V.

PAPERS DELIVERED by the WARDEN OF THE STANDARDS.—COMPLETION of REVERIFICATION of OFFICIAL STANDARD WEIGHTS, and original VERIFICATION of NEW STANDARD WEIGHTS.

PART I.—REVERIFICATION of PLATINUM AUXILIARY STANDARD WEIGHTS as the BASIS for reverifying the OFFICIAL STANDARD BULLION WEIGHTS; PRINCIPLES and PRACTICE of COMPARISON of STANDARD WEIGHTS differing in their Densities.

CONTENTS.

	Page
Comparison of official troy standard based on 10 oz. and 2 oz. decimal bullion weights - - - - -	31
Reverification of all these standards to be now based on platinum troy pound T - - - - - -	„
Reverification of troy oz., the standard or unit of bullion weight, per 16 Vict. c. 29. - - - - -	„
Proposed reverification of T by comparison with RS -	„
And, together with the auxiliary weights, with the imperial standard - - - - - - -	32
List of platinum auxiliary weights - - -	„
Principles and mode of verifying standard weights differing in density from comparisons in air - - -	„
Density of bodies - - - - - - -	„
Their specific gravity - - - - - -	„
Determination of their volume - 1, by cubic measurement - -	„
Determination of their volume - 2, by their specific gravity - -	„
Determination of their volume - 3, by the stereometer - - -	„
Importance of determining the density of standard weights	
Calculation of densities - - - - - -	„
Difference of density in standards of the same description of metal - - - - - - -	„
And corresponding difference of weight in a vacuum and in ordinary air - - - - - - -	33
Assumed density of the brass commercial pound, and of the lost standard - - - - - -	„
Density of quartz pound - - - - - -	„
And of iron and gold - - - - - -	„
Specimens of pounds made of different materials, showing the form and relative size - - - - -	34
Determination of relative weight of two standards differing in density when weighed in air - - - - -	35
Mode of correction by deducting weight of air displaced -	„
Data for ascertaining weight of air displaced - -	„
Method of computing it - - - - - -	„
Professor Miller's formula - - - - -	„
His tables - - - - - - -	„
This formula employed for the corrections of the weighing of the official standards - - - - - -	36
Determination of actual weight in air of a compared standard - - - - - - -	„
Principle of such determination laid down by Dr. W. A. Miller - - - - - - - -	„
Short practical directions for reductions of weighings -	37
True weight of every standard, its weight in a vacuum -	„
But the apparent weight in air generally accepted as the actual weight - - - - - - -	„
Commercial standard of weight in air - - - -	„
Expediency of establishing a standard temperature and pressure of air - - - - - - -	„
Other standard temperatures and pressure adopted for gases, and in other countries - - - - - -	„
Results of actual weighings - - - - -	„
Densities and errors of standard pounds, as determined by Professor Miller - - - - - -	„
Details and result of Professor Miller's comparison of T and RS in 1845 - - - - - -	38
The same result shown also from different reductions now made in the Standards Department - - -	38
Mode of weighing used by Professor Miller - -	„
Differences in Professor Miller's several comparisons of T and RS - - - - - - -	„
Greatest despatch requisite for accurate weighings -	39
Same opinion expressed by Mr. Hassler - - -	„
And agrees with experience of Standards Department.—Less number of weighings consequently adopted, as in France - - - - - - - -	„
Failures in first comparisons of primary standards in the Department - - - - - - -	„
Precautions since taken, and additional apparatus procured - - - - - - - -	„
Balance used, and mode of weighing - - -	„
Finely graduated index to balance - - - -	„
Form and size of T and of RS - - - -	40
Actual comparisons of T and RS, and reduction of weighings - - - - - - - -	„
Satisfactory results of these comparisons - - -	41
Determination of the standard weight of T, and the auxiliary platinum standards, by comparison with PS -	„
Comparison of T and the auxiliary platinum standards with PS - - - - - - -	„
Reverification of Q, V, and W - - - -	42
Actual comparisons with PS - - - - -	„
Comparisons of all the auxiliary platinum standards -	43
Actual weight of T, based by Professor Miller on its relation to the lost standard - - - - -	44
And that of the auxiliary platinum standards on T -	45
Actual weight of PS based on T and the auxiliary standards - - - - - - -	„
Process now reversed, and all weights based on PS -	„
Absolute weight of both T and PS proved to be unaltered since 1845 - - - - - - -	„
Standard weight of T and the auxiliary platinum weights	
Comparison of bullion standards with T and RS - -	„
Mean result of direct comparisons - - -	46
Comparisons among themselves of bullion standards from 1 oz. to 10 oz. - - - - - - -	„
Determination of standard weight of 10 oz. and 2 oz. together, as compared with T and RS - - -	„
And of their weight separately - - - -	„
Difference in their standard weight in 1868 as compared with 1854 - - - - - - -	„
Consequent correction of the weight of the official troy pound based on these two standards - - -	„
Standard weight of official troy pound also checked by comparison with O - - - - - -	„
Comparison of O with T - - - - - -	„
And of official troy pound with O, and with 10 + 2 oz. bullion standards - - - - - -	„
Final determination of standard weight of official troy standards - - - - - - -	47

Comparison of official troy standards based on 10 oz. and 2 oz. decimal bullion weights.

It has been stated (App. IV. p. 29.) that the reverification of the official standards of troy weight, so far as it has been carried out, was based upon the comparison of the official standard troy pound of 1824, with the two gilt gun metal bullion standards of 10 oz. and 2 oz.; the actual weight of these two bullion weights together being assumed to be that ascertained by Professor Miller in 1855, viz., ·00011 grain less than the imperial standard.

Reverification of all these standards now based on platinum troy pound T.

Since the comparisons of the official troy standards were made, the platinum standard troy pound T, which was used by Professor Miller in the original comparison and verification of the imperial standard pound, and the actual weight of which, in terms of the imperial standard is recorded, has been transmitted by the Astronomer Royal to the Standards Department. It has thus become available not only for the reverification of the two bullion standards of 10 oz. and 2 oz., and the consequent completion of the reverification of the troy standards, but also as the most authoritative basis of comparison of all the decimal bullion standards.

Proposed reverification of troy ounce, the standard or unit of bullion weight, 16 Vict. c. 29.

In the Act 16 Vict. c. 29, passed in 1853, for regulating bullion weights, and establishing bullion standards, the troy ounce was declared to be the standard or unit of bullion weight, and all bullion weights were to be multiples or decimal parts of such ounce. It is obvious therefore that the first object in the reverification of the bullion standards must be to redetermine the exact weight of the bullion ounce as the legal basis of comparison and verification of the other bullion standards. The best mode of attaining this object appears to be that adopted by Professor Miller in the original verification of the bullion standards under 40 oz., by combining the standard bullion ounce with other bullion standards, and comparing them with T in a series of comparisons so as to deduce the actual weight of each bullion standard so compared.

Prof. Miller's paper, p. 937.

But it would also appear to be requisite to reverify the

Proposed reverification

Appendix V.—*continued.*

of T by comparison with RS.
Miller, p.817.

actual weight of T. In the first instance, the most obvious course was to compare T with RS, the platinum standard troy pound belonging to the Royal Society, with which it had already been compared 122 times by Professor Miller in 1845, and to ascertain if the same difference in weight now existed between them. For this purpose, at the request of the Warden to the Royal Society, RS was lent to him on 11th November 1867, and it has thus enabled a comparison to be made not only between T and RS, but of the 10 oz. and 2 oz. bullion standards with each of these troy standard pounds. This standard RS is one of the two platinum troy pounds upon which, with the consent of the Astronomer Royal, Professor Miller resolved in 1844 to rest for the evidence of the weight of the lost standard, and it was considered by him to be of greater authority than any other platinum troy pound. The other platinum troy pound was that belonging to Professor Schumacher, Sp. From the observations made by Professor Miller, he considered that RS had undergone no sensible change since its comparison by Captain Von Nehus for Professor Schumacher with the Parliamentary standard in 1829. It was also from comparisons with these two platinum troy pounds that the actual weight of T was originally determined in 1844.

p. 774.

p. 772.

p. 806.

The imperial standard itself being the only platinum avoirdupois pound in the custody of the Department, it has been found necessary to use it for this special purpose, although as a rule it is contrary to the established regulations to use this primary standard for the Departmental comparisons. The two gilt gun metal official copies, Nos. 31 and 34, have also been used for comparison with T and the auxiliary weights. The copy No. 31 was one of the official standards transmitted to the Paris Exhibition, and has since been returned.

And, together with the auxiliary weights, with the imperial standard.

A further reverification of the weight of T has also been thought advisable by comparing it together with each of the several platinum auxiliary weights A, B, C, and D, and F and G, with the weight of the imperial standard pound.

List of platinum auxiliary weights.

It has appeared also to be expedient to reverify all the platinum auxiliary weights by comparing them with T and with each other. The following is a list of these auxiliary weights which were used in the construction and verification of the imperial standard pound, and have since been transferred to the Standards Department:—

A	of the nominal weight of	1240	grains.
B	„	1240	„
C	„	1240	„
D	„	1240	„
F	„	800	„
G	„	440	„
H	„	360	„
K	„	80	„
L	„	80	„
M	„	80	„
N	„	80	„
R	„	40	„
S	„	40	„

There are also the following weights used with reference to the difference of the weight of air displaced by the volume of 7,000 grains of metal of the density of the lost standard of brass, and 7,000 grains of platinum, being about 0·645 grain of air, viz., 10 weights Q each = 0·645 grain, V = 6·451 grains, W = 12·901 grains.

Principles and mode of verifying standard weights differing in density from comparisons in air.

But before proceeding to state the processes and results of the several comparisons of these standards, all of which have been made in the Department by weighings in air, it may be expedient to place upon record the principles and the practical mode by which the relative as well as the actual weight of standards is to be determined with due accuracy from these weighings in air, when the standards are composed of metals differing so materially in density as platinum, and brass or gun metal, and consequently in their bulk or volume as compared with their weight.

Density of bodies.
Dr. W. A. Miller's Elements of Chemistry, p. 38.

The density of a body is defined to be the *mass* contained in a unit of its volume. The unit of density which is adopted is the volume of an equal bulk of distilled water at its maximum density, being at the temperature of somewhat less than 4° Centigrade, or 39° 2″ Fahrenheit. The densities of bodies are in the direct ratio of their masses, and in the inverse ratio of their volumes.

Their specific gravity.

The *density* of a body thus shows the mass contained in its volume when referred to a uniform standard. This *specific density* is to be distinguished from its *specific gravity*, which shows its weight in relation to its volume, also when referred to a uniform standard. The specific gravity of a body is defined to be the *weight* of a unit of its volume. The numbers used to represent the specific gravity of solids or liquids are obtained by comparing a known weight of the body under experiment with the weight of an equal bulk of distilled water which has been selected as the standard of reference; both the specific gravity and the density of pure water, at the same temperature, being invariable. In this country the determination of the specific gravity is ordinarily made at a temperature of 60° Fahrenheit.

The relation of the bulk or volume of a body to its weight is expressed both by its density and its specific gravity, these terms being often used indiscriminately. But the former term is more strictly applicable to solid bodies, and the latter to liquids and gases.

Determination of their volume.

To ascertain the density of a body it is requisite that its volume should be determined, as this density cannot be directly ascertained. The actual volume may be determined,—

1. By cubic measurement.

1. By cubic measurement, when the form of the body admits of the measurement being accurately made; but this very rarely occurs.

2. By their specific gravity.

2. By immersion in water, or by ascertaining its specific gravity. This is the readiest and most accurate mode of determining its volume, but its immersion in water is not always practicable, or it may be injurious to the body under experiment.

3. By the stereomete

3. A third mode has been adopted for ascertaining the volume of standard weights, which it was considered would be damaged by immersion in water, by an instrument on the principle of the stereometer invented by M. Say for the purpose of determining the specific gravity of gunpowder. This instrument is described by Professor Miller in his paper of 1856, upon the construction of the new standard pound, p. 799. It consists of two glass tubes, A and B, of equal diameter, communicating with each other at their lower ends. The tube A is graduated by lines traced upon the glass. It communicates at its upper end with a cup capable of being closed so as to be air-tight. The standard weight or body under experiment is to be placed in this air-tight cup. The volume of the air in the cup is measured by means of mercury poured into the tube B, by which A becomes a barometrical tube. The volume of the standard weight may be thus ascertained, from the difference of the volume of air in the cup before and after the standard weight is placed in it.

Importan of determining th densities of standa weights.

The importance of determining the density of every standard weight was strongly urged by Professor Schumacher in his paper upon the "Comparison of the late "Imperial Standard Troy Pound weighed with a platina "copy of the same, and with other standards of authority," read before the Royal Society on 16th June 1836. He says,—

Phil. Tra 1836, p. 45

"It is to be hoped that no pound will in future ever be declared a legal standard unless its specific gravity and expansion (the knowledge of which is indispensible, even for a single comparison with a good balance) are previously determined with the greatest possible precision. A standard pound is intended for the purpose of obtaining from it accurate copies, and it therefore involves a contradiction if those elements are not well ascertained."

See Miller, p. 875.

One of the greatest difficulties experienced by the Standards Committee in the construction of the new standard pound arose from the density of the lost standard having never been ascertained. It is also remarkable that the density of the French standard platinum kilogramme des Archives had never been ascertained, except approximately by cubic measurement, until it was determined by Professor Miller in 1844 by means of the stereometer. (*Par un oubli inconcevable, la Commission des Poids et Mesures n'a pas fait connaître la densité précise de ce kilogramme.—Pratique de Poids et Mesures, par M. Saigey, Paris,* 1856, *p.* 63.)

Calculatio of densiti

p. 792.

The mode and formula of calculating the densities of standard weights are given by Professor Miller in his account of the construction of the new standard pound. This process is not required at the present time in the case of the several official standards of platinum and gilt gun metal now in the Standards Department, their densities having been already ascertained and stated by Professor Miller. At any future time, when it may be necessary to determine the density of any standard, this may be effected by the means of the stereometer used by Professor Miller, and which is to be transferred to this Department. The immersion in water of any of the official standards has been decidedly objected to by the Astronomer Royal, as being likely to injure them.

pp. 805 a 945.

Differenc of density standard the same descripti of metal.

The following table shows the greatest differences in the densities of a considerable number of standard pound weights of the same description of metal, which were ascertained by Professor Miller (pp. 805 and 945). It shows also the relative difference in the weight of each specified

Appendix V.—*continued.*

standard when weighed in a vacuum and when weighed in air of mean ordinary temperature and barometric pressure (t=65°·66 Fahr., and b=29·75 inches of mercury at the temperature of melting snow), as compared with the corresponding difference in the Imperial standard; this amount of difference being that between the weight of air displaced by each standard (which is shown in a separate column) and by the Imperial standard.

Metal.	Designation of Standard.	Density at 32 Fahr.	Difference of density in Standards of similar metal.	Relative difference of weight in a vacuum and in ordinary air, as compared with that of the Imperial Standard.	Weight of air displaced by each Standard.
				grains.	grains.
Platinum - -	Imperial standard pound, PS -	21·1572	—	—	0·39644
	Parliamentary copy, No. 1 -	21·1671	+0·0099	+0·00019	0·39625
Bailey's metal, copper 32, tin 5, zinc 2.	Gilt gun metal lb., No. 21 -	7·97370	—	−0·65594	1·05238
	„ No. 17*b* -	8·55888	+0·58518	−0·58399	0·98043
Brass or bronze - -	Russian pound, No. 8. - -	7·872	—	—	—
	„ N. - -	8·508	+0·636	—	—
Brass - - -	Schumacher's troy lb., K. -	7·994	—	−0·53756	0·86377
	Alchorne's troy lb., O, 1758 -	8·403	+0·409	−0·49576	0·82197

The relative difference of weight in the two Russian pounds is not shown, the Russian standard being stated to vary from the Imperial in the proportion of 6318·5 to 7,000 (Kelly, p. 301). A platinum troy pound of the same density as the imperial standard pound would displace $0{\cdot}32621\ \left(\frac{5760}{7000}\ 0{\cdot}39644\right)$ grain of ordinary air.

And corresponding difference of weight in a vacuum and in ordinary air.

It should be observed that the relative difference in weight of the four first specified standards does not exactly agree with that stated in Professor Miller's table at page 945, where he gives the density and the actual errors in grains of the several standards when compared *in a vacuum with the new imperial standard pound, made of platinum,* designated as PS; and also gives the errors in grains of these standards when compared *in air of the stated temperature and atmospheric pressure with a brass pound of the apparent weight of* $\frac{7000}{5760}$ *of that of the lost standard.* This brass pound is taken to be the commercial standard (see p. 862), and is designated as W. The errors thus given are as follows:—

Designation of Standard.	In a Vacuum when compared with the Platinum Standard.	In specified Air, when compared with the Brass Commercial Standard.	Difference of Weight in Air.
	gr.	gr.	gr.
Platinum, Imperial Standard Pound, PS - -	0·00000 - -	0·63407 too heavy -	+0·63407
„ Parliamentary Copy, No. 1 - -	0·00051 too heavy -	0·63477 „ -	+0·63426
Gilt Gun Metal Pound, No. 21 - - -	0·03971 „ - -	0·01777 „ -	−0·02194
„ „ No. 17 - - -	0·04428 too light -	0·00542 „ -	−0·03886

It will be seen that the cause of the figures in the last column of this table not agreeing with those in the last column but one of the first table, is that in the first table the comparison in air is made *with the apparent weight of the platinum imperial standard pound;* in the second with that of *the brass commercial standard pound.*

Assumed density of the brass commercial standard, and of the lost standard. Miller, p.862.

By adding the weight of specified air displaced by the imperial standard to its difference in weight in the same air when compared with the brass commercial standard, as shown in the last table, it would appear that this brass commercial standard is considered to displace 1·03051 grains of air at the stated temperature and barometric pressure of 65°·66 F. and 29·75 in. Now, it may easily be computed that a brass weight of 7,000 grains, displacing this weight of air, must have its density = 8·1430; and if this was the density of the lost standard, which was a brass weight of 5,760 grains, it must have displaced 0·84796 grains of air of the stated temperature and barometric pressure. This result, however, differs somewhat from that assumed by Professor Miller from the best information he was able to obtain of the density of the lost standard, designated as U. He supposed it to be 8·15084 (pp. 805 and 819), or to be the same as that of Mr. Vandome's brass troy pound of 1758, known as V, which was nearly the average density of brass or bronze weights. With a density of 8·15084, U must have displaced 0·84715 grain of the specified air. The difference amounts only to 0·00081 grain, and is too small to affect the accuracy of weighings in ordinary air, where no corrections are applied for the weight of air displaced. It arises from, and is a necessary consequence of, the nearly corresponding difference in the *legal weight* of the imperial standard, viz., 7,000 grains and its *computed weight in terms of the lost standard,* viz., 7,000·00093 (p. 861). The weight of the imperial standard PS was computed on the assumption that the density of the lost standard U was 8·15084. At the close of the work, on re-calculating the weight of PS with the new value of the weight of air that had been obtained a very short time before by Regnault, the resulting weight in a vacuum of PS was 7,000·00093 grains, of which U contained 5,760. If the resulting weight of PS had been exactly 7,000 grains, it would have implied that the density of U = 8·15084; and when the legal weight of PS was declared to be = 7,000 grains, it implied that the density of U = 8·1430, computed from the legal weight of PS. To this slight extent, therefore, the assumed density of the existing brass commercial standard differs from that which was assumed to be the density of the lost standard. Professor Miller considered (p. 862) the result which determined the apparent weight in the specified air of the brass commercial standard, upon which the actual weight in air of all brass and bronze weights is now based, and its consequent density to be 8·1430, as not affected by the uncertainty of the value of the specific gravity of the lost standard.

Density of quartz pound.

In addition to the densities stated in the first table it may be stated that at 18° C. or 64°·40 Fahr., the density of the quartz pound constructed by Professor Miller was found by him to be 2·649 only, its weight in a vacuum being 2·36797 grains heavier than the imperial standard, whilst its error when compared in similar air with a brass pound of the same density as the lost standard, was found to be 0·40147 grain too light, showing a decrease of weight when thus weighed in ordinary air of 2·76944 grains, as compared with its weight in a vacuum. The large amount of air displaced by this quartz pound renders its use as a standard objectionable.

And of iron and gold.

The density of iron, of which metal commercial weights are ordinarily made, is not stated by Professor Miller, no iron weights having come under his observation. These iron weights are adjusted by plugs of lead. It may be observed that at the time when the lost standard was originally constructed by Lord Carysfort's Parliamentary Committee of 1758, it was contemplated to construct the standard pound of gold, and by a special order of the House of Commons of 2nd April 1760, a troy standard pound of *fine gold* was ordered to be made. But there is no record of such gold pound having been constructed. The relative density of iron, gold, &c., may be seen from

Appendix V.—*continued.*

the average specific gravity of these and the before-mentioned metals of which standards are composed, taken from published tables:—

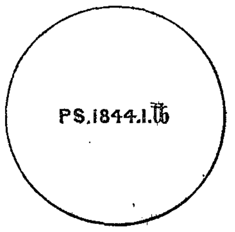
Art. Hydrostatics Lib. Useful Knowledge, 1829.

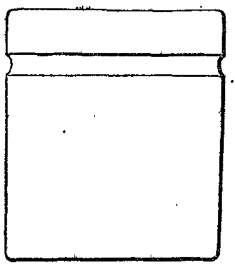
Platinum	21·47.
Gold	19·3.
Lead	11·35.
Copper	8·90.
Brass and bronze	7·824 to 8·296.
Cast iron	7·248.
Wrought iron	7·788.
Steel	7·8.
Tin	7·29.
Zinc	6·900 to 7·191.
Porcelain, from China	2·384.

The relative volume of a pound weight of platinum, bronze or brass, iron, earthenware,* and quartz, may be seen from the following specimens, their form and exact size being shown:—

Specimen of pounds made of di ferent ma terials, showing t form and r lative size.

Upper Surface of Platinum Standard Pound.

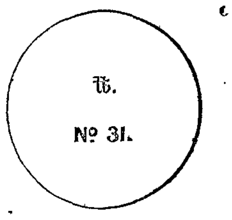


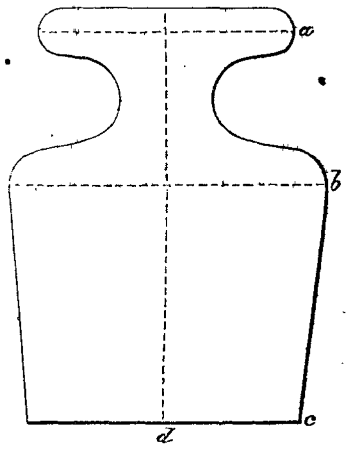


Imperial Standard Pound of Platinum. Cylindrical with a groove.

Height = 1·35 inch.
Diameter = 1·15 inch.

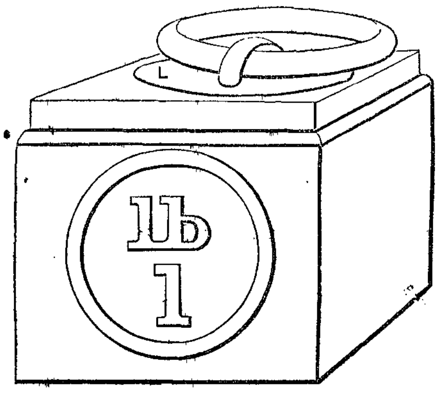
Upper Surface of Gilt Gun Metal Standard Pound.





Official Standard Pound, Gilt Gun Metal.

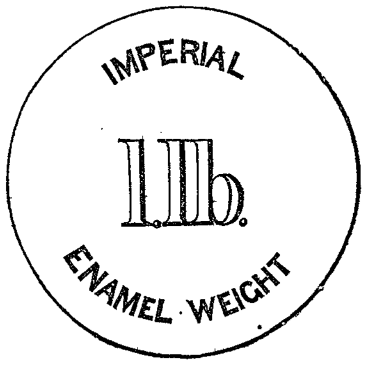
Size: Diameter at $a = 1·25$ inch.
„ $b = 1·65$ „
„ base $c = 1·47$ „
Height $d = 2·2$ inches.

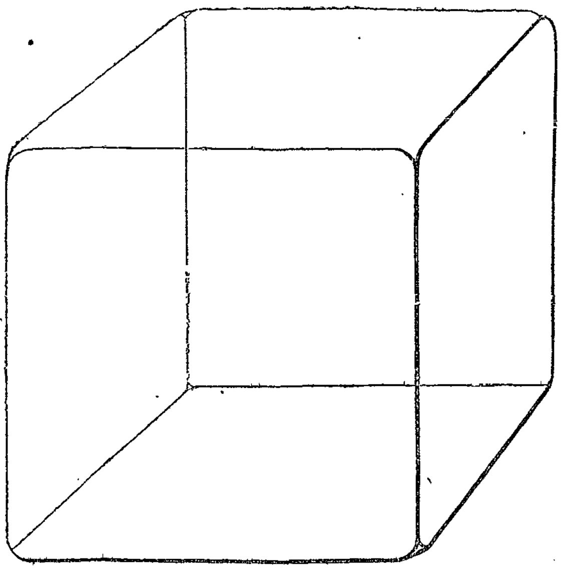


Ordinary One Pound Commercial Weight, Iron Black Japanned, Edges Rounded.

Base = 1·675 inch square.
Height = 1·2 inch exclusive of staple and ring.
L, lead plug = 1·1 inch diameter, for holding the ring staple, and for adjustment.

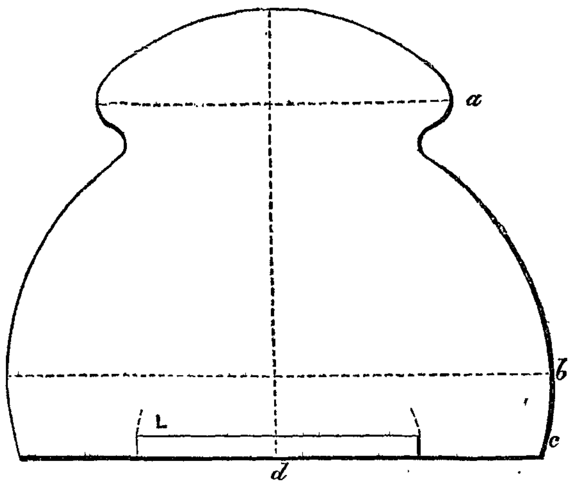
Upper Surface of Enamelled One Pound Weight.





Quartz Pound in Standards Department, bearing no Mark.

Size = 2·17 inches cube, edges rounded.



Ordinary Commercial Enamel Weight (Wedgwood).

Diameter at $a = 2$ inches.
„ $b = 2·85$ „
„ base $c = 2·75$ „
Height at $d = 2·5$ „
L, cavity for lead, for adjustment and stamp, diameter 1·45 inches.

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* Enamelled earthenware weights are now much used by tradesmen. Some inspectors, however, refuse to stamp them, as they are brittle and liable to be chipped. Such injury may, indeed, be remedied by re-adjustment with additional lead; but the real objection to the use of these weights is that they may be made heavier, at the will of their owner, by soaking them in water, or lighter from drying them by heat. A new enamelled one pound weight (from which the above diagram was taken) was weighed in the Standards Department against the official standard on 6th June, and after being soaked in water during the night, was wiped dry and weighed again on the following morning, and found to have gained 45·392 grains. Any chipping off of the enamel must necessarily facilitate the absorption of water by the earthenware.

Appendix V.—*continued.*

Determination of relative weight of two standards differing in density when weighed in air.

In order to ascertain the true relative weight, as well as the actual weight of standards differing in density, when weighed in air, it is necessary to allow for the weight of the volume of air displaced by each standard. Thus in weighing two standards for the purpose of determining their relative weight, it becomes necessary to reduce these weighings to a vacuum, by deducting the weight of the volume of air displaced by each standard.

Mode of correction by deducting weight of air displaced. p. 791.

The correction is to be made according to the formula thus given by Professor Miller:—

"If the weights P and Q appear to be equal when weighed in air, weight of P — weight of air displaced by P = weight of Q — weight of air displaced by Q."

The justness of this mode of correction is obvious from the following considerations:—

A body weighed in water weighs less than when weighed in air, by the difference between the weight of the water and the weight of the air displaced by its volume. In like manner a body weighed in air weighs less than when weighed in a vacuum by the weight of the air which its volume displaces. It follows that a brass weight of the exact weight of a pound when weighed in a vacuum must, when weighed in air, weigh less than a pound by the weight of air which it displaces, and its true weight when weighed in air must therefore be found by deducting the weight of air thus displaced.

But the weight of a given volume of air is necessarily more or less according to its temperature, the pressure of the atmosphere, and other conditions affecting it.

Data for ascertaining weight of air displaced.

The weight of air displaced by each standard is to be ascertained from the following data:—

1. The mean temperature of the air during the comparison.
2. The mean barometric pressure reduced to 32° F. and corrected by deducting the pressure of vapour in the air.
3. The density of the metal of which each standard weight is composed.
4. Its coefficient of expansion.
5. The weight of each standard.

From data 1 and 2 the ratio of the density of the air at the given temperature, barometric pressure, and pressure of vapour to the maximum density of water must be ascertained. This ratio is also affected by the height above the mean level of the sea, and the latitude of the place where the comparison is made, as the force of gravity differs accordingly. The tables constructed by Professor W. H. Miller for the reduction of his weighings, founded on Regnault's observations, were adapted to the cellar under the Mineralogical Museum at Cambridge, where the weights were compared by him in lat. 52° 12′ 18″, about eight mètres above the mean level of the sea. They also served for the reduction of the weighings in Somerset House, lat. 51° 30′ 40″, 29·56 mètres above the mean level of the sea, if the stated logarithms for finding the density of the air were diminished by 0·000028. The same correction has also been applied to the weighings at the Standards Office. p. 785.

Method of computing it.

The method of computing the weight in grains of air displaced by each standard is by adding the logarithms of the following terms:—

1. The given barometric pressure in inches, corrected and reduced to 32° F.
2. The given ratio of the density of the air to the maximum density of water.
3. The ratio of the density of the metal of which the standard is composed at 0° to its density at the given temperature, and coefficient of the linear expansion of the metal.
4. The weight of the standard in grains.

And by deducting from the sum the logarithm of—

5. The ratio of the density of the standard at 0° to the maximum density of water.

Miller, p.790.

Water is stated by Professor Miller, on the authority of Playfair and Joule,* to be at its maximum density at the temperature of 3·945 C. or 39·101 F.

Method of computing it. Professor Miller's formula. p. 791.

The formula for ascertaining the weight of air displaced by each standard (P and Q) is thus stated by Professor Miller. He uses the centigrade scale of thermometer, and gives the necessary tables of the logarithms of the several terms of the formula:—

"Let t be the temperature of the air in centesimal degrees, b its pressure in millemètres of mercury at 0°, v the pressure of the vapour contained in it, also in millemètres of mercury, $h = b - 0·378\,v$, ΔP, ΔQ, ratios of the densities of P and Q at 0° to the maximum density of water; ePt, eQt, the expansions in volume of P and Q. Then log. weight in grains of the air displaced by P.

$= \log. h + \log. A_t + \log. (1 + e\,Pt) + \log.$ weight of P in grains $- \log. \Delta P$.

"If vP be taken to denote the volume of P at 0°, the unit of volume being the volume of a grain of water at its maximum density,

$\log. vP = \log.$ weight of P in grains $- \log. \Delta P$.

"The expression for the weight of air displaced by Q differs from the above only in the substitution of Q for P.

"The value of h is deduced from b by means of Table II., assuming that the amount of vapour in the air is two-thirds of the quantity in saturated air. Table I. gives the second term for the expression for the weight of air displaced, and Tables III., IV., and V. give the third term according as the weight is of brass, bronze or platinum."

PROFESSOR MILLER'S TABLES FOR REDUCTION OF WEIGHINGS.

Professor Miller's tables.

TABLE I.

LOGARITHMS of the RATIO of the DENSITY of the AIR, at a given TEMPERATURE, to the MAXIMUM DENSITY of WATER.

$10 + \log. 1·293893 - 3 - \log. 760 - \log. (1 + 0·003656t.)$

t.	10 + log. A*t.*	Diff.
0	4·231085	
1	4·229500	1585
2	4·227921	1579
3	4·226347	1574
4	4·224780	1567
5	4·223217	1563
6	4·221661	1556
7	4·220110	1551
8	4·218565	1545
9	4·217025	1540
10	4·215490	1535
11	4·213961	1529
12	4·212437	1524
13	4·210919	1518
14	4·209406	1513
15	4·207898	1508
16	4·206396	1502
17	4·204898	1498
18	4·203406	1492
19	4·201919	1487
20	4·200436	1483
21	4·198959	1477
22	4·197488	1471
23	4·196020	1468
24	4·194558	1462
25	4·193101	1457
26	4·191648	1452
27	4·190201	1447
28	4·188758	1443
29	4·187320	1438
30	4·185887	1433

TABLE II.

CORRECTIONS of the BAROMETRIC PRESSURE as affected by the HYGROMETRIC CONDITION of the AIR.

Value of $0·378 \times \frac{2}{3} v_t$, where v_t is the Maximum Pressure of Vapour at the Temperature t, in Millimètres of mercury at 0°, according to Regnault's Observations.

t.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.
0	1·16	1·17	1·18	1·18	1·19	1·20	1·21	1·22	1·23	1·24
1	1·25	1·25	1·26	1·27	1·28	1·29	1·30	1·31	1·32	1·33
2	1·34	1·35	1·36	1·37	1·37	1·38	1·39	1·40	1·41	1·42
3	1·43	1·44	1·45	1·46	1·47	1·48	1·49	1·50	1·51	1·53
4	1·54	1·55	1·56	1·57	1·58	1·59	1·60	1·61	1·63	1·64
5	1·65	1·66	1·67	1·68	1·69	1·70	1·72	1·73	1·74	1·75
6	1·76	1·78	1·79	1·80	1·81	1·82	1·84	1·85	1·86	1·87
7	1·89	1·90	1·91	1·93	1·94	1·95	1·96	1·98	1·99	2·01
8	2·02	2·03	2·05	2·06	2·08	2·09	2·10	2·12	2·13	2·15
9	2·16	2·17	2·19	2·21	2·22	2·24	2·25	2·27	2·28	2·29
10	2·31	2·32	2·34	2·35	2·37	2·39	2·40	2·42	2·44	2·45
11	2·47	2·48	2·50	2·52	2·53	2·55	2·57	2·58	2·60	2·62
12	2·64	2·65	2·67	2·69	2·71	2·72	2·74	2·76	2·78	2·80
13	2·81	2·83	2·85	2·87	2·89	2·91	2·93	2·94	2·96	2·98
14	3·00	3·02	3·04	3·06	3·08	3·10	3·12	3·14	3·16	3·18
15	3·20	3·22	3·24	3·26	3·28	3·31	3·33	3·35	3·37	3·39
16	3·41	3·43	3·46	3·48	3·50	3·52	3·54	3·57	3·59	3·61
17	3·63	3·66	3·68	3·71	3·73	3·75	3·78	3·80	3·82	3·85
18	3·87	3·90	3·92	3·95	3·97	4·00	4·02	4·04	4·07	4·09
19	4·12	4·15	4·17	4·20	4·22	4·25	4·28	4·30	4·33	4·36
20	4·38	4·41	4·44	4·47	4·49	4·52	4·55	4·58	4·61	4·63
21	4·66	4·69	4·72	4·75	4·78	4·81	4·84	4·87	4·90	4·92
22	4·95	4·99	5·02	5·05	5·08	5·11	5·14	5·17	5·20	5·23
23	5·26	5·30	5·33	5·36	5·39	5·43	5·46	5·49	5·52	5·56
24	5·59	5·62	5·66	5·69	5·73	5·76	5·80	5·83	5·87	5·90
25	5·93	5·97	6·01	6·04	6·08	6·12	6·15	6·19	6·22	6·26
26	6·30	6·34	6·37	6·41	6·45	6·49	6·53	6·56	6·60	6·64
27	6·68	6·72	6·75	6·79	6·83	6·87	6·91	6·95	6·99	7·03
28	7·08	7·12	7·17	7·21	7·25	7·29	7·34	7·38	7·42	7·46
28	7·51	7·55	7·59	7·64	7·68	7·73	7·77	7·82	7·86	7·91
30	7·95	8·00	8·04	8·09	8·14	8·18	8·23	8·28	8·32	8·37

Memoirs of the Chemical Society, vol. 3, p. 199.

Appendix V.—*continued.*

TABLE III.

LOGARITHMS of the RATIO of the DENSITY of BRASS at 0° to its DENSITY at *t*°, and their ARITHMETICAL COMPLEMENTS assuming the COEFFICIENT of LINEAR EXPANSION = 0·00001722.

t.	Log. Br.	10 — log. Br.	——
0	0·0000000	10·0000000	
1	0·0000224	9·9999776	
2	0·0000449	9·9999551	
3	0·0000673	9·9999327	
4	0·0000897	9·9999103	
5	0·0001122	9·9998878	
6	0·0001346	9·9998654	
7	0·0001570	9·9998430	
8	0·0001795	9·9998205	
9	0·0002019	9·9997981	
10	0·0002243	9·9997757	
11	0·0002467	9·9997533	
12	0·0002691	9·9997309	
13	0·0002916	9·9997084	
14	0·0003140	9·9996860	
15	0·0003364	9·9996636	
16	0·0003588	9·9996412	
17	0·0003812	9·9996188	
18	0·0004037	9·9995963	
19	0·0004261	9·9995739	
20	0·0004485	9·9995515	0·1 22
21	0·0004709	9·9995291	0·2 45
22	0·0004933	9·9995067	0·3 67
23	0·0005158	9·9994842	0·4 90
24	0·0005382	9·9994618	0·5 112
25	0·0005606	9·9994394	0·6 135
26	0·0005830	9·9994170	0·7 157
27	0·0006054	9·9993946	0·8 179
28	0·0006277	9·9993723	0·9 202
29	0·0006502	9·9993498	
30	0·0006726	9·9993274	

TABLE IV.

LOGARITHMS of the RATIO of the DENSITY of the ALLOY adopted by MR. BAILY for the STANDARD BARS at 0° to its density at *t*°, the COEFFICIENT of its LINEAR EXPANSION at 17° being 0·00001705 according to the OBSERVATIONS of MR. SHEEPSHANKS.

t.	Log. Ba.	10 — log. Ba.	——
0	0·0000000	10·0000000	
1	0·0000222	9·9999778	
2	0·0000444	9·9999556	
3	0·0000666	9·9999337	
4	0·0000888	9·9999112	
5	0·0001111	9·9998889	
6	0·0001333	9·9998667	
7	0·0001555	9·9998445	
8	0·0001777	9·9998223	
9	0·0002009	9·9997991	
10	0·0002221	9·9997779	
11	0·0002443	9·9997557	
12	0·0002665	9·9997335	
13	0·0002887	9·9997113	
14	0·0003109	9·9996891	
15	0·0003331	9·9996669	
16	0·0003553	9·9996447	
17	0·0003775	9·9996225	
18	0·0003997	9·9996003	0·1 22
19	0·0004219	9·9995781	0·2 44
20	0·0004441	9·9995559	0·3 67
21	0·0004663	9·9995337	0·4 89
22	0·0004884	9·9995116	0·5 111
23	0·0005106	9·9994894	0·6 133
24	0·0005328	9·9994672	0·7 155
25	0·0005550	9·9994450	0·8 178
26	0·0005772	9·9994228	0·9 200
27	0·0005994	9·9994006	
28	0·0006216	9·9993784	
29	0·0006437	9·9993563	
30	0·0006659	9·9993341	

TABLE V.

LOGARITHMS of the RATIO of the DENSITY of PLATINUM at 0° to its DENSITY at *t*°, and their ARITHMETICAL COMPLEMENTS, assuming the COEFFICIENT of the LINEAR EXPANSION of PLATINUM to be 0·00000900.

t.	Log. P.	10 — log. P.	——
0	0·0000000	10·0000000	
1	0·0000117	9·9999883	
2	0·0000235	9·9999765	
3	0·0000352	9·9999648	
4	0·0000469	9·9999531	
5	0·0000586	9·9999414	
6	0·0000704	9·9999296	
7	0·0000821	9·9999179	
8	0·0000938	9·9999062	
9	0·0001055	9·9998945	
10	0·0001173	9·9998828	
11	0·0001290	9·9998710	
12	0·0001407	9·9998593	
13	0·0001524	9·9998476	
14	0·0001641	9·9998359	
15	0·0001759	9·9998241	
16	0·0001876	9·9998124	
17	0·0001993	9·9998007	
18	0·0002110	9·9997880	0·1 12
19	0·0002227	9·9997773	0·2 23
20	0·0002345	9·9997655	0·3 35
21	0·0002462	9·9997538	0·4 47
22	0·0002579	9·9997421	0·5 59
23	0·0002696	9·9997304	0·6 70
24	0·0002813	9·9997187	0·7 82
25	0·0002931	9·9997069	0·8 94
26	0·0003048	9·9996952	0·9 105
27	0·0003165	9·9996835	
28	0·0003282	9·9996718	
29	0·0003399	9·9996601	
30	0·0003516	9·9996484	

This formula and the tables used for the corrections of the official standards.

Under Professor Miller's instructions, this formula and the accompanying tables have been employed for the corrections of the weighings in air of the official standards differing in density. In his letter to the Warden of the Standards of 31st July 1867, he states it to be "a trouble-"some process certainly, but the only way of obtaining "a result accurate enough for inquiries like those in "which we are at present engaged."

In these official corrections for the weight of air displaced, Mr. Glaisher's tables, based upon Professor Schumacher's formula, have been used for correcting the barometrical pressure by reducing it to 32° Fahrenheit; and Dowling's metrical tables, as well as the Smithsonian tables, have been found serviceable for converting Fahrenheit's thermometrical scale to the centigradé, as well as for the conversion of the barometrical scale of inches and decimal parts to that of millemètres.

Determination of *actual weight* in air of a compared standard.

It is not only the true *relative weights* (or the true difference of weight) of any two compared standards differing in their densities, which may be determined by ascertaining the weight of the volume of air displaced by each at a given temperature and pressure: the same data will also enable the *actual weight* in air of every standard so compared to be determined.

Principle of such determination laid down by Dr. W. A. Miller.

The principle upon which such weighings in air should be corrected in order to ascertain the *actual weight* is thus stated by Dr. W. A. Miller, in his "Elements of Che-"mistry," page 43.

"The apparent weight of every substance in the atmosphere (that is, the force with which it appears to be drawn to the earth) is always a little less than its actual weight, because the air presses upon and supports the body with the same force with which it would support a portion of air of the same bulk as the body itself. The weight of this displaced portion of air may be easily ascertained if the specific gravity of the body be known. * * This weight must be added to that actually found; at the same time a similar and opposite correction will be required for the metallic weights used in the experiment, because they will also appear to be lighter than they really are, and an amount of weight greater than the true one will be required to effect the counterpoise. If therefore the weights have the same specific gravity, the two corrections will neutralize each other; but if there is a great difference between them the correction will be of importance. The true weight sought will be thus obtained:—Add to the weight of the body in air the weight of the bulk of air which it has displaced, and deduct from this the weight of the bulk of air displaced by the weights employed."

Appendix V.—*continued.*

"The correctness of the foregoing observations admits of an easy experimental illustration. If a light body, such as a piece of cork, be suspended in air from one end of a scale-beam, and be counterpoised at the other end by a metallic weight, then on placing the apparatus under the receiver of an air pump, and exhausting the air, the cork will gradually acquire the preponderance; but on again admitting the air, the equilibrium will be restored."

It follows that in all weighings of two bodies against each other, that which has the greatest density will appear to be heavier as compared with the other, when weighed in air, than when weighed in a vacuum.

Short practical directions for reductions of weighings.

The following are short practical directions for the correction of weighings, when the weight of air displaced has been ascertained:—

1. *To reduce apparent weight in air to weight in a vacuum.*

If in air $A = B - n$.
Then in a vacuum $A = B - n$ + excess of weight of air displaced by A.
or − excess of weight of air displaced by B.

Thus (Miller, p. 803), in air $O = T - 0{\cdot}13196$ gr.
O displaces 0·8146 gr.
T „ 0·3231 „

Excess displaced by O, 0·4915 + 0·4915

Whence in a vacuum $O = T + 0{\cdot}35954$ gr.

2. *To reduce weight in a vacuum to apparent weight in air.*

If in a vacuum $A = B - n$
Then in air $A = B - n$ − excess of weight of air displaced by A.
or + excess of weight of air displaced by B.

Thus (Miller, p. 861), in a vacuum
$PS = T + F + G + Q$ - - 0·00338 gr.
In air ($t. = 65{\cdot}66°$ F. $b. =$ 29·75 in., PS displaces 0·39644 gr.
$T + F + G + Q$ displace 0·39628 „

Excess displaced by PS. 0·00016 −0·00016

Whence in air ($t. = 65{\cdot}66°$ F. $b. =$ 29·75 in.) $PS = T + F + G + Q$ 0·00354 gr.

True weight of every standard, its weight in a vacuum.

The *true* weight of every standard or other body is its weight in a vacuum. In the Act of 1855 for legalizing the restored standards, the imperial standard pound deposited at the Exchequer is declared to be the standard measure of weight, and one equal seven-thousandth part to be equal to a grain. It is true that the Act does not directly provide for this standard being the true legal weight of a pound *when weighed in a vacuum;* but the preamble of the Act recites the construction of this standard pound by the Standards Committee, and it is shown by Professor Miller, the member of the committee to whom the construction of this standard pound was entrusted, in his paper upon the subject, that it is *in a vacuum only* that the imperial standard pound is of the true weight, and neither too heavy nor too light.

p. 945.

But the apparent weight in air generally accepted as the actual weight.

But whilst the *true weight* of a standard for the most accurate comparisons with other standards, and for scientific purposes, is thus to be determined in a vacuum, for all ordinary purposes weighings are made in air, and thus the *apparent weight* in air of a standard or other weight is generally accepted as its true weight. In fact it appears to be absolutely necessary thus to state the apparent weight in air of a standard as its true weight, when it is to be used for comparison with other weights, without any correction for the amount of air displaced. Thus the actual weight of the several official standards of avoirdupois weight as recently determined and stated in paper No. 5 laid before the Standards Commission, and recited in the first report of the Warden of the Standards, is based upon the mean actual weight of the two gilt gun-metal copies, Nos. 31 and 34, of the imperial standard pound, *when weighed in air of the mean ordinary temperature and atmospheric pressure specified* by Professor Miller as before stated. The apparent weight in air of these avourdupois standards has therefore been officially adopted as their actual weight.

Commercial standard of weight in air.

It is indeed only in scientific weighings, such as the comparisons of standards which demand the utmost precision, that it is requisite to take into account the weight of air displaced by the body weighed. This correction may be and is altogether disregarded in the ordinary weighings of trade and commerce, where iron weights are generally used for the larger operations, and brass weights for the smaller. For all such purposes, therefore, it becomes necessary to establish a commercial standard of weight composed of metal of the average density of commercial weights, and which is to denote the true weight of 7,000 grains when weighed in ordinary air. The official standard avoirdupois pound is practically established as this commercial standard, and it is with reference to a similar theoretical commercial standard that Professor Miller has assigned the errors of the several standards verified by him, when weighed in ordinary air. By the correction recently made of the official standard avoirdupois pound, it has become identical in weight with this theoretical commercial standard. The difference between the apparent weight in ordinary air of the brass commercial standard pound and that of the imperial standard of platinum exceeds $\frac{6}{10}$th of a grain, being actually 0·63407 grains, the platinum standard appearing to be heavier by the difference between the weight of air displaced by the two standards respectively. This is, in fact, as has been already stated, the computed difference between the imperial avoirdupois standard pound of platinum and a brass weight equal to $\frac{7000}{5760}$ of the lost troy standard, when both are weighed in ordinary air, the two standards being exactly equal in weight when weighed in a vacuum.

Miller, p. 894.

For the purpose of comparing standards weighed in air it is obviously expedient to reduce all the weighings to one uniform standard temperature and pressure.

Expediency of establishing a standard temperature and pressure of air.

p. 769.

The mean ordinary temperature of the air, taken at 65·66° Fahrenheit, and the mean atmospheric pressure of 29·75 inches of mercury, corrected and reduced to the temperature of melting snow, 32° Fahr., in Somerset House, were the temperature and pressure to which Professor Miller reduced the weighings in air of all the standards. His reason was that this was the mean of the temperatures and pressures observed during Professor Schumacher's comparisons at Somerset House, in 1829, of his own platinum troy pound Sp. and the platinum troy pound of the Royal Society RS, with the lost standard. *It may therefore be convenient to continue this precedent and to establish this temperature and pressure to be the standard for all the official weighings in air that require correction.*

Other standard temperatures and pressures adopted for gases in other countries.

It should, however, be observed that a temperature of 60° Fahrenheit and a barometric pressure of 30 inches is generally employed as the standard for gases and vapours. Under the Sale of Gas Act, 22 & 23 Vict. c. 66. s. 2., the standard temperature of the unit of gas measure is fixed at 62° Fahrenheit, the barometer being at 30 inches. Unfortunately the standard temperature and pressure adopted in England differs from that employed in nearly every other country. Almost all foreign writers on science adopt the French plan, by which 0° C. (32° Fahrenheit) is made the standard temperature, and 760 millimètres (29·922 inches) the height of the barometer which is assumed as the standard pressure.

Dr. W. A. Miller's Elements of Chemistry, p. 38.

Results of actual weighings.

Having thus detailed the principles and method of verifying standard weights differing in density when weighed in air, it remains to state the results of the weighing of the several standards compared, and of the reductions of these weighings in air.

Densities and errors of standard pounds, as determined by Prof. Miller.

It may be convenient first to state the densities, and errors both in a vacuum and in ordinary air, of the following standards as determined by Professor Miller.

The following determinations are shown at page 945 of his paper on the construction of the new standard pound.

Designation.	Density at 32° Fahr.	Error when compared in a Vacuum with the Imperial Standard.	Error when compared with the Commercial Standard in Air of the Standard Temperature and Pressure.
		Gr.	Gr.
Platinum troy pound T - - - -	21·16610	0·52934 too light	0·00745 too light.
Gilt gun metal, imperial pound, No. 31 - -	8·51444	0·04410 „	0·00080 too heavy.
„ „ No. 32 - -	8·47042	0·03448 „	0·00304 „
„ „ No. 33 - -	8·47902	0·04144 „	0·00063 too light.
„ „ No. 34 - -	8·51472	0·04584 „	0·00089 „

Appendix V.—*continued.*

The actual weight of T, as well as that of the auxiliary weights A, B, C, D, F, taken together, and intended to be equal to a troy pound, was originally determined from comparison with the two platinum troys pound RS and Sp. These two platinum troy pounds instead of being true troy pounds, and consequently equal to the standard in a vacuum, had been originally adjusted so as to appear as heavy as the lost standard of brass *when weighed in air of ordinary density*, and were therefore each lighter than the standard by about 0·53 grain, the weight of air contained in a space equal to the difference between the volume of the lost standard and that of each of these platinum standards.

Miller, p. 806.

The density of the platinum auxiliary weights is stated by Professor Miller (p. 808) to be the same as that of T. Their values in grains were determined by his latest comparisons in September 1856, from a small number of observations, to be as follows, in a vacuum:—

$$\begin{array}{l} A = 1239 \cdot 89046 \\ B = 1239 \cdot 88759 \\ C = 1239 \cdot 88729 \\ D = 1239 \cdot 88619 \\ \left.\begin{array}{l} F = 799 \cdot 92487 \\ G = 439 \cdot 96005 \end{array}\right\} 1239 \cdot 88492 \end{array}$$

These values differ somewhat from those stated in Professor Miller's paper (p. 827) to have been the results of numerous comparisons in 1846. The difference is caused partly by a small number of comparisons only having been made in 1856, but principally from the weights A, C, and F having been altered in the meantime by Professor Miller. In 1845 these three weights were found to be deficient, and for the comparisons of all the platinum auxiliary weights in 1846, they were used with the addition of small bits of wire to make up their deficiency. With this addition their weights were as follows:—

gr.
A = 1239·88622
C = 1239·88597
F = 799·92769

After all these comparisons had been completed Professor Miller fused bits of electrotype gold on them to supply their deficiency of weight instead of using bits of wire, after which he redetermined the values of all these auxiliary weights with the result now stated.

It will thus be seen that whilst the actual weight of A, C, and F respectively has been altered since these weights were used for the comparisons made to determine the weight of the imperial standard in 1846, no such alteration has been made in B, D, and G. The following table shows the actual weight of each of these auxiliary standards as ascertained in 1846 (excluding the bits of wire used with A, C, and F), and the difference of their weight as determined in 1856.

Auxiliary Platinum Standards.	Weight in 1846.	Difference in 1856 as compared with 1846.
	grains.	grains.
A - - -	1239·84622	+0·04424
B - - -	1239·88605	+0·00154
C - - -	1239·85497	+0·03232
D - - -	1239·88580	+0·00039
F - - -	799·88769	+0·03718
G - - -	439·96009	−0·00004

Details and result of Prof. Miller's comparison of T and RS in 1845.

The density of RS was taken by Professor Miller (p. 769) to be 21·1874, as adopted by Schumacher.* In 1845 Professor Miller determined from a mean of 122 comparisons (p. 819), T = RS — *0·00429 grain*, when reduced to a vacuum. Assuming the weight of T, as already stated, to be in a vacuum 0·52934 grain lighter than the imperial standard, this determination shows RS to have been 0·52505 grain (*0·52934 — 0·00429*) lighter in a vacuum than the imperial standard. As the reverification of T is now after the lapse of 23 years based upon a new series of comparisons with RS, the details of Professor Miller's comparisons in 1845 may be briefly stated.

Professor Miller's comparisons and their result were as follows:—

	t.	*b.*	*gr.*
1845, January 16	9·05	763·46	10 T ≏ 10 RS — 0·04539
July 28	17·01	753·95	24 T ≏ 24 RS — 0·10632
August 14	15·96	759·34	44 T ≏ 44 RS — 0·21227
August 15	16·29	755·39	44 T ≏ 44 RS — 0·19871
			122 T ≏ 122 RS — 0·56269

Whence in air (*t.* = 15·72°, *b.* = 757·19) T = RS — 0·00461.

As T was found to displace 0·33037 grains of air and RS 0·33005 grains of air, therefore in a vacuum T = RS — 0·00429 grains. RS therefore was 0·52505 grains lighter than the imperial standard.

It will be seen that this result was obtained by at once taking the mean of the 122 comparisons at the mean temperature and barometic pressure and reducing the mean result to a vacuum. The reductions were made by means of Schumacher's tables.

The same result shown also from different deductions now made in the Stan ards Department.

The same result may be shown in a different form by giving the mean result of *each series* of comparisons, and by reducing each result to a vacuum, and showing the mean of the four results. This is accordingly now given. The reductions have been made in the Standards Department according to Professor Miller's formula and by means of his tables. These differ slightly from those of Schumacher, thus necessarily causing a slight difference in the result, and they have served as a test of the accuracy of the process of reduction by the officers of the Department.

From 10 comparisons in air T = RS — 0·00454 *gr.*, or in a vacuum T = RS — 0·00421 *gr.*
„ 24 „ T = RS — 0·00443, „ T = RS — 0·00411
„ 44 „ T = RS — 0·00482, „ T = RS — 0·00450
„ 44 „ T = RS — 0·00448, „ T = RS — 0·00420
Mean „ T = RS — 0·00425

Mode of weighing used by Prof. Miller.

Professor Miller's mode of proceeding in the comparison of two standard weights was as follows:—He adopted Gauss's method of weighing, already described in Appendix III., p. 16. The balance used by him (Miller, p. 762) was one of extreme delicacy, made by Barrow, and has been recently transferred to the Standards Department. It is now being put into order by Messrs. Oertling, and some further improvements made in it, under Professor Miller's directions. The index scale was marked upon a thin slip of ivory, a little more than half an inch long, divided into spaces of about 0·01 inch each. It was fixed to the right-hand end of the beam, and oscillated with it. This scale was viewed through a compound microscope having a single horizontal wire fixed in the focus of the eye piece. An arrangement was contrived by Professor Miller so that the weights could be transferred from one pan to the other without opening the balance case.

The reading of the divided scale was noted at the end of each of four consecutive oscillations, of which the second, third, and fourth only were taken for determining the mean resting point of the balance, viz.:—

$\frac{1}{4}$ (2nd reading + 4th reading) + $\frac{1}{2}$ 3rd reading.

The first oscillation being apt to exhibit irregularity, its notation was useful merely in detecting any error which might be made in the notation of the third oscillation.

After determining the mean resting point of the balance with the weight in the pan on the side under observation, Professor Miller changed the weights and repeated the same process of weighing; thus as soon as possible completing a single comparison of the two standard weights, which occupied about twelve minutes of time. It will be seen that a single weighing, or observation, was taken from four oscillations of the beam of the balance, and that two observations, including a change of weights, completed a single comparison.

Differenc in Profes Miller's comparis of T and and their causes.

The greatest difference in any one of the four mean results above stated, from the mean of all, or its actual error, does not exceed 0·00025 grain. Professor Miller has,

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* Neither the density of RS, nor its specific gravity has been actually determined. Schumacher states (Phil. Trans., 1836, p. 490), that its specific gravity was unknown, and until it was determined, he supposed it to be of the same specific gravity with Sp. Nor was the specific gravity of Sp ever determined by direct experiment of weighing in water, but from weighing in water another weight of similar platinum which was made for the purpose.

Appendix V.—*continued.*

however, stated the result of each of the 122 comparisons made by him, and the corresponding difference appears to be greater in the results of the several comparisons in each series. Thus on 15th August 1845, when the largest amount of discordance occurred in the consecutive comparisons, the greatest difference from the mean, or the actual error, was 1·73 divisions, or 0·00475 grain, each division being equal to 0·00279 grain. These differences in the weighings made in the course of a series of comparisons on the same day, are referred to by Professor Miller (p. 765) as arising from alterations in the temperature during the process, affecting the two arms of the balance unequally, and also the sensibility of the balance. He afterwards found (p. 943) that the weights themselves were differently affected by changes of temperature. As the result of his experience, therefore, he considered it of importance to make all the more important weighings within the narrowest practicable limits of time, as the chance of a larger irregular error belonging to a small number of comparisons was less injurious to accuracy than the error to be apprehended in a larger number of comparisons extending over a considerable interval of time.

Greatest despatch requisite for accurate weighings.

Same opinion expressed by Mr. Hassler.

In a paper transmitted with the American balance and standards by Mr. Hassler in 1843, he expresses a similar opinion, and says, "It will be found that the weighings "executed with the greatest despatch are the best."

And agrees with experience of Standards Department; less number of weighings consequently adopted, as in France.

In this opinion of Professor Miller, both Mr. Chaney and I entirely concur, after our experience in the weighings primary standards with our most delicate balances. As there is at present no contrivance in the balances for changing the weights in the pans without opening the balance case, we have come to the conclusion that it will be the safer plan to make only five observations before changing the weights in their pans, and as many more for ascertaining the value of one division of the index. Each double series of five observations constitutes one comparison. This is the number of observations adopted by the French Commission in the comparison of the official kilogramme du Conservatoire with the primary kilogramme des Archives, made in 1864.

Failures in first comparisons of primary standards in the Department.

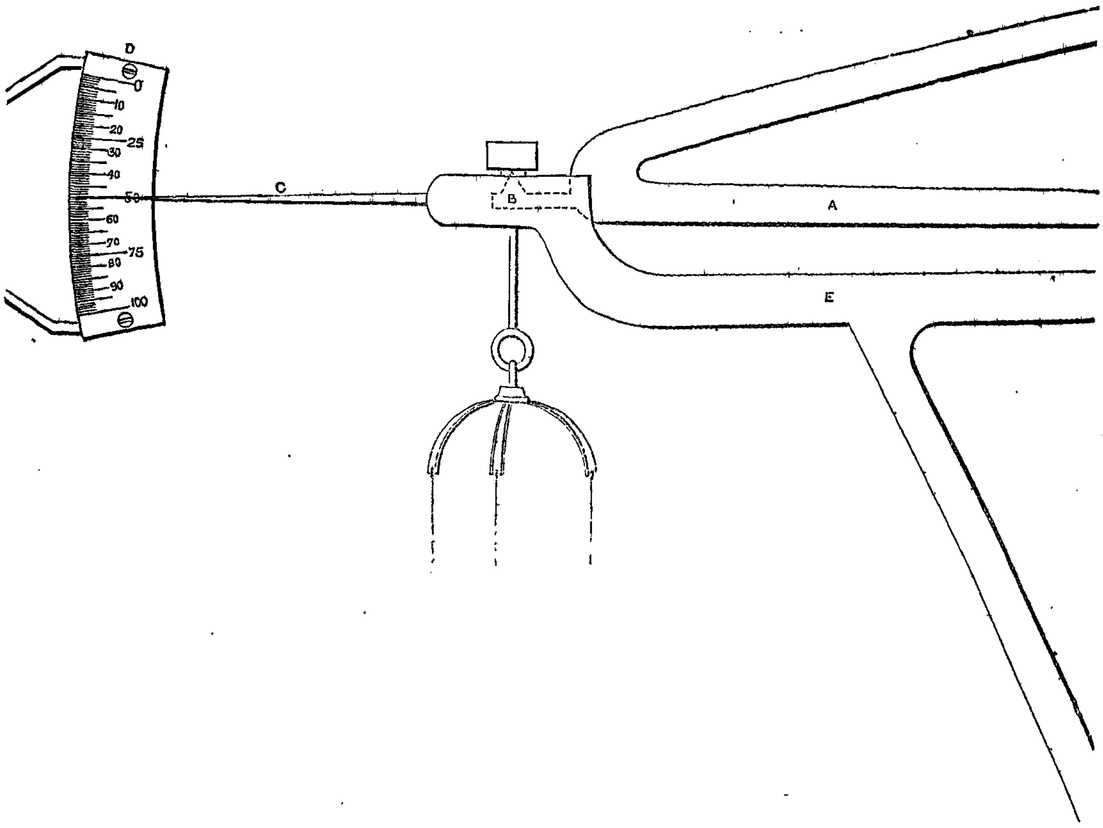
In the first departmental comparisons of T and RS, which were attempted by making 10 observations before changing the standards in their pans, and 10 after, and as many more for finding the value of one division of the index, thus making 40 observations, there was found to be so much discordance in the readings as to make the result valueless, and several days were thus expended only in gaining experience in weighing. It was found also that there was too much vibration and disturbance from currents of air in the weighing room for those comparisons requiring the greatest accuracy, and the balance was consequently moved to the strong room in the basement of the building. There it was at first necessary, from the day-light being obscured, to use lamp-light for the reading of the index, but the changes of temperature consequent on this arrangement again caused the discordance to be too large for the result to be accepted.

Precautions since taken, and additional apparatus prepared.

After consultation with Mr. Oertling, he furnished the Department with a reflector to be placed inside the balance case so as to throw the day-light on the index, and with a plate glass screen to be placed between the observer and the balance-case; the additional precaution was taken of mounting a small telescope on a stand so as to remove the observer about four feet from the balance case, in order that the heat of his body might not affect the balance. The magnifying power of this telescope enabled a much more finely graduated index for the balance to be substituted; this is engraved in ivory, and contains 100 divisions in the space of 1·6 inch; its form, and that of the pointer and part of the balance, are shown, somewhat reduced in size, in the accompanying drawing. By the aid of the strong light thrown by the reflector, and of the magnifying power of the telescope, the readings can be confidently taken to the 10th part of a division by estimation.

Balance used, and mode of weighing.

The balance to which this index is attached, as shown below, is No. 3 balance, the beam being 16 inches in length between the two points of suspension of the pans; the length from the centre of oscillation to the end of the index needle is 11 inches. This balance is used for comparing standard weights from 2 oz. up to one imperial pound; a similar index has also been substituted on the other three balances made by Messrs. Ladd and Oertling. As before stated (Appendix III., p. 19) Gauss' method of weighing is employed and is noted on the printed official form. It is now the practice to take the third and fourth oscillations as the highest and lowest readings of a single observation, merely noting the first and second oscillations for the purposes of correcting the readings.

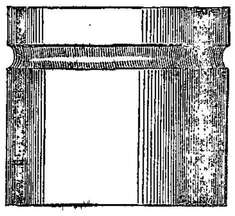


A. End of brass beam of balance, No. 3, vibrating on a knife edge upon agate bearings, and supported on a brass pillar.
B. Knife edge, being the point of suspension of left-hand pan attached to three platinum wires.
C. Steel index pointer.
D. Finely graduated ivory scale, fixed to side of balance case.
E. Brass frame for supporting the beam and relieving the knife edges when the balance is not actually in use.

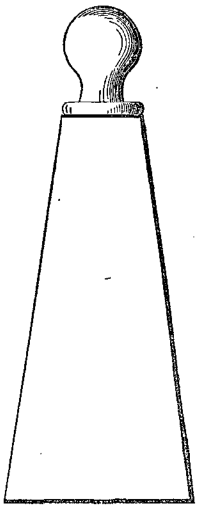
Appendix V.—*continued.*

Form and size of T and RS.

The form and size of the two platinum standard troy pounds T and RS are as follows, T being cylindrical with a groove, and RS a truncated pyramid surmounted by a knob.



PLATINUM TROY POUND
T
OF THE STANDARDS DEPARTMENT.



PLATINUM TROY POUND
RS
OF THE ROYAL SOCIETY.

The diameter of the base of T is 1·125 inch, the height 1·07 inch; the length of the side of the base of RS is 0·95 inch, the total height 2·66 inches.

Actual comparisons of T and RS.

ACTUAL COMPARISONS OF T AND RS.

The following more satisfactory comparisons were made in the strong room in the basement of the building:—

First comparison on 9th January 1868, by Mr. Chisholm and Mr. Chaney together, between 2 p.m. (*t* in balance case=60·08°) and 3 p.m. (*t*=59·80°). Mean *t*=59·94°, corrected *b*=29·88 inches.

The mean resting point of each standard placed in the left-hand pan was as follows:—

T

	Highest.	Lowest.	Mean.
(1)	55·8	49·4	52·60
	55·2	50·	52·60
	55·2	50·	52·60
	55·5	50·	52·75
	55·3	50·	52·65
	55·2	50·2	52·70
		Mean=	52·65

RS

	Highest.	Lowest.	Mean.
(4)	56·8	50·2	53·50
	57·	50·2	53·60
	57·	50·1	53·55
	56·7	50·1	53·40
	56·2	50·1	53·15
	56·8	50·	53·40
		Mean =	53·43

53·43
52·65
2) 0·78

Or T = RS – 0·39 div.

Adding the balance weight 0·00966 grains to the left hand pan,—

	Highest.	Lowest.	Mean.
(2)	57·	49·2	53·10
	56·	50·	53·
	57·4	50·	53·70
	56·3	50·1	53·20
	58·5	50·	54·25
		Mean =	53·45

	Highest.	Lowest.	Mean.
(3)	59·5	49·3	54·40
	59·5	50·	54·75
	59·3	50·3	54·80
	60·3	50·	55·15
	59·8	50·3	55·05
		Mean =	54·83

Or T = RS – 0·69 div.

Mean T=RS–0·54 div.

To find the value of one division of the index,—

53·45	54·83
52·65	53·33
0·80	1·40

Mean 1·10 div.=0·00966 gr. or 1 div.=0·00878 gr.

Hence *t*=59·94° F. (15·52° C.), *b*=29·88 in. (759·0376$^{\text{mm.}}$)
T=RS–0·00466 gr.

Reduct of weig

Reduction of Weighings.

	T		RS
(1) Log *h*	= 2·8783641		
(2) A_t	= 4·2071170		
(3) 1+*e*P*t*	= 0·0001820		
(4) Weight 5,760grs.	= 3·7604225		
	10·8460856		10·8460856
(5) Deduct ΔT	= 1·3256600	ΔRS=	1·3260800
	9·5204256		9·5200056

Whence weight of air displaced by T = 0·33146 gr. by RS=0·33113 gr.
Excess of ditto = 0·00033 gr.

Therefore in a vacuum T=RS–0·00433 gr.

Second comparison on 12th February 1868, by Mr. Chisholm alone, between 2 p.m. and 3.55 p.m. Two thermometers being placed inside the case, one close to each pan, at 2 p.m., *lt* = 60·2°, and *rt*=60°; at 3.55 p.m., *lt*=58·5, *rt*=58·5.

Mean *t* = 59·17 F. and corrected *b* = 30·4659 inches.

T

	Highest.	Lowest.	Mean.
(1)	53·	49·7	51·35
	53·8	48·9	51·35
	53·2	49·4	51·30
	59·6	43·3	51·45
	52·7	50·	51·35
		Mean	51·36

RS

	Highest.	Lowest.	Mean.
(4)	57·5	50·2	53·85
	58·	49·4	53·70
	57·2	50·1	53·65
	60·	47·5	53·75
	57·4	49·8	53·60
		Mean	53·71

Or T = RS – 1·175 div.

Adding balance weight 0·00966 grains to the left-hand pan,—

	Highest.	Lowest.	Mean.
(2)	59·3	50·8	55·05
	59·4	50·5	54·95
	60·9	49·1	55·
	59·9	50·	54·95
	59·3	50·5	54·90
		Mean	54·95

	Highest.	Lowest.	Mean.
(3)	65·9	51·2	58·55
	66·1	51·	58·55
	66·	51·	58·50
	66·1	50·9	58·50
	65·8	51·	58·40
		Mean	58·50

Or T = RS – 1·775 div.

Mean T=RS–1·475 div.

To find the value of one division—

54·95	58·50
51·36	53·71
3·59	4·79

Mean 4·19 div.=0·00966 gr. or 1 div.=0·00230 gr.

After the fourth series of weighings, a further series, being a repetition of (1), was taken to test there being no variation in the balance, viz.:—

T

	Highest.	Lowest.	Mean.
(5)	55·	49·9	52·45
	53·4	50·1	51·75
	54·3	48·6	51·45
	52·4	49·1	50·75
	52·3	49·1	50·70
		Mean	51·42

Hence—

t = 59·17° F. (15·50° C.), and *b* = 30·4659$^{\text{in.}}$ (773·8197$^{\text{mm.}}$)
T=RS–0·00339 gr.

Appendix V.—*continued.*

Reduction of Weighing.

T RS
(1) Log. h - - = 2·8867445
(2) A_t - - - = 4·2077570
(3) $1+ePt$ - - = 0·0001594
(4) Weight 5,760 grs. = 3·7604225

10·8540834 10·8540834
—ΔT= 1·3256600 —ΔRS 1·3260800

9·5284234 9·5280034

Whence weight of air displaced by T } = 0·33762 gr. by RS 0·33730 gr,
Excess of ditto = 0·00032 gr.
Therefore in a vacuum T=RS—0·00307 gr.

As a consequence of these two standards being very nearly equal in weight, it may be observed that on the first comparison between them, on 26th January, the oscillation of the balance, during any one of the 10 weighings, did not amount to seven divisions of the index, although 100 divisions measure no more than 1·6 inch, and the pointer of the index is 11 inches from the centre of oscillation of the balance. In the second comparison, on 12th February, the greatest divergence of the index pointer was very little more, except in one of the weighings, when the resting bar of the balance was intentionally lowered more quickly, in order to give a freer play to the balance. In some of the earlier weighings, which were rejected on account of their discordant results, it was thought that some of these discordances might have been caused by the *vis inertiæ* of the balance not having been sufficiently overcome. In the following comparison, therefore, by Mr. Chaney, an additional weight of 0·05 grain was placed in the left-hand pan in order to increase the oscillation.

Third comparison, on 14th February 1868, between 12 at noon and 1.15 p.m., the two thermometers in the case and a third attached to the barometer varying only 0·1°: Mean = 54·03°, and b = 30·175 in.

T

	Highest.	Lowest.	Mean.
(3)	70·	50·2	60·1
	69·	51·	60·
	71·8	48·	59·9
	70·	50·1	60·05
	70·	50·2	60·01
		Mean	60·03

RS

	Highest.	Lowest.	Mean.
(2)	72·	51·5	61·75
	73·	50·5	61·75
	74·	49·5	61·75
	73·5	50·	61·75
	73·	50·4	61·7
		Mean	61·74

Or T = RS – 0·855 div.

Adding balance weight 0·00966 gr. to the left-hand pan,—

	Highest.	Lowest.	Mean.
(4)	73·2	51·3	62·25
	73·6	50·2	61·9
	73·	50·	61·5
	73·	51·	62·
	74·	50·2	62·1
		Mean	61·95

	Highest.	Lowest.	Mean.
(1)	96·	32·	64·
	77·	50·3	63·65
	76·8	51·	63·9
	87·	41·1	64·05
	76·	51·1	63·55
		Mean	63·83

Or T = RS – 0·94 div.

Mean T = RS – 0·8975 div.

To find the value of one division—

61·95	63·83
60·03	61·74
1·92	2·09

Mean 2·005 div.=0·00966 gr., or 1 div.=0·00481 gr.

Whence—

t = 54·03° F. (12·238° C.), b = 30·175 in. (766·431$^{\mathrm{mm.}}$),
T=RS – 0·00431 gr.

Reduction of Weighing.

T RS
(1) Log. h - - = 2·8829348
(2) A_t - - - = 4·2120757
(3) ePt - - - = 0·0001434
(4) Weight 5,760 grs. = 3·7604225

10·8555764 10·8555764
—ΔT= 1·3256600 1·3260800

9·5299164 9·5294964

Whence weight of air displaced by T } =0·33878 gr., and by RS=0·33845.
Excess of ditto - =0·00033 gr.
Therefore in a vacuum T=RS – 0·00398 gr.

Two more indirect comparisons of T with RS were subsequently made, as will presently be shown in the course of the verification of the bullion standards, and with the following results, viz. :—

When reduced to a vacuum,—

10 oz.+2 oz.= T+0·47511 gr.
" =RS+0·47008 "
Whence T=RS—0·00506 gr.
10 oz.+1 oz.+1 oz.= T+0·47555 gr.
" =RS+0·47085 "
Whence T=RS—0·00470 "
Result of first comparison - T=RS—0·00466
" second " - T=RS—0·00307
" third " - T=RS—0·00398
" fourth " - T=RS—0·00506
" fifth " - T=RS—0·00470

Mean result of 140 observations - T=RS—0·00429 gr.

Satisfactory results of these comparisons.

It may fairly be considered, from the remarkable agreement of this result with that of 122 comparisons of T and RS made by Professor Miller in 1845, which also showed T=RS—0·00429 gr., that no appreciable variation in the relative weight of the two platinum standard troy pounds T and RS has occurred during the 23 years which have elapsed since they were compared by Professor Miller. It may also be assumed that the two standards are practically unaltered in their actual weight.

In ordinary standard air (log. Δ=0·707832—10) T displaces 0·32606 grains of air, and RS 0·32575, being an excess by T of 0·00031; whence T=RS—0·00460. As the actual weight of T in standard air was found to be 5759·99255 gr. of the lost standard of brass, 7,000 grains of which were taken to be the commercial standard, it follows that in the same air RS=5759·99715 grains of the commercial standard.

DETERMINATION OF THE STANDARD WEIGHT OF T AND THE AUXILIARY PLATINUM WEIGHTS, BY COMPARISON WITH THE IMPERIAL STANDARD, PS.

Comparison of T and the auxiliary platinum standards with PS.

For the final determination of the standard weight of T, it has been found necessary to compare it with the Imperial Standard PS itself, which was accordingly removed by the Warden of the Standards from the strong room where it is kept deposited, a special minute being made.

For making the following comparisons, the balance No. 3 was in most cases used, after it had been put into perfect condition by Mr. Oertling. Its adjustment was considered necessary in consequence of the considerable difference in the value of one division of the index, found during the comparisons of T and RS in the month of February. All the following comparisons were more conveniently made in the room in the Norman tower, the fittings of this room having been completed, and where there is little vibration or change of temperature, the walls being about five feet thick, and the floor supported on a vaulted and groined arch. There are also double windows in this room for the purpose of equalizing the temperature.

The observations for determining the standard weight of T and of the auxiliary platinum standards have been similar to those made by Professor Miller in 1845, the results of which are stated by him at p. 827 of his Memoir. The platinum troy pound T was constructed so as to appear of the same weight *in ordinary air* as the lost standard, or as 5,760 grains of the commercial standard of brass. A space equal to the difference between the volume of 7,000 grains of metal of the density of the commercial standard of brass, and 7,000 grains of platinum, contains about 0·645 grains of air. Calling this Q, ten small platinum weights have been constructed, and adjusted with the greatest precision, so that no sensible difference could be detected between them, and each being as nearly as possible equal to 0·645 gr.

Appendix V.—*continued.*

Reverification of Q. V. and W.

In order to determine with the greatest possible precision the error of each of these ten weights Q, two other platinum weights were constructed, V of 6·451 gr. and W. of 12·901 gr. The result of several comparisons made by Professor Miller in 1845 (see p. 829) showed—

$$V+10\,Q=W-0{\cdot}00062 \text{ gr.}$$
$$\text{and} \quad Q=0{\cdot}64509 \text{ gr.}$$

All the auxiliary platinum weights have now been deposited in the Standards Department. From 20 comparisons made on 14th May 1868, it has been found that $V+10\,Q=W-0{\cdot}00068$ gr., and it may accordingly be assumed that the weight of V, Q, and W has remained unaltered since 1845.

Actual comparisons with PS.

The following are the results of the comparisons of the several platinum weights with the Imperial standard :—

—	Date of Comparison.	Number of Weighings.	Results of Weighings.	Value of 1 div. of Index.	Mean Temp.	Bar. corrected to 0° C.
	1868.		gr.	gr.	° C.	mm.
(a)	May 7	25	$T+A+Q=PS-0{\cdot}00453$	0·00127	15·	761·478
(b)	„ 6	25	$T+B+Q=PS+0{\cdot}00254$	0·00159	15·575	765·322
(c)	„ 7	25	$T+C+Q=PS+0{\cdot}00256$	0·00130	15·	761·478
(d)	„ 6	25	$T+D+Q=PS+0{\cdot}00090$	0·00143	15·58	766·020
(e)	„ 7	25	$T+F+G+Q=PS+0{\cdot}00147$	0·00123	15·	761·478
			These weighings were made by Mr. Chaney, and in order to check their accuracy, a second comparison of T + D + Q with PS was made by the Warden of the Standards, the auxiliary weight D being selected, on account of the little change in its weight, according to the comparisons made by Professor Miller in 1846 and in 1856.			
(d*)	May 25	25	$T+D+Q=PS+0{\cdot}00093$	0·00124	17·38	756·373
Total number of weighings		150				

The closeness of the results of these two comparisons of T+D+Q with PS may serve as a test of the accuracy of the weighings. It may be desirable to give *in extenso* the details of this last comparison with the imperial standard. They are as follows :—

25th May 1868. *Comparison of auxiliary platinum standard weights T+D+Q with PS.*

—		Beginning at 1.8 p.m.	End at 3.40 p.m.	Mean.	Bar. corrected and reduced to 0° C. or 32° F.
Bar.	=	29·86 in.	29·88 in.	29·87 in.	29·779 in. *or* 756·373$^{\text{mm}}$.
Temp. on bar.	=	62·0°	62·8°	62·4°	
Right therm. in case	=	62·9°	63·6°	63·3°	
Left do. do.	=	63·0°	63·6°		

T+D+Q

	Vibrations of Balance.				Sum.	Resting Point.
	Not taken.		Taken.			
	1. Highest.	2. Lowest.	3. Highest.	4. Lowest.		
(1)	50·8	39·	50·1	39·1	89·2	44·6
	49·9	39·5	49·3	40·7	90·	45·
	49·7	41·1	49·1	41·9	91·	45·5
	49·8	41·	49·3	41·6	90·9	45·45
	50·6	40·	50·	40·8	90·8	45·4
			247·8	204·1	451·9	225·95
					Mean	45·19

PS

	Vibrations of Balance.				Sum.	Resting Point.
	Not taken.		Taken.			
	1. Highest.	2. Lowest.	3. Highest.	4. Lowest.		
(4)	49·6	37·3	49·	37·8	86·8	43·4
	49·4	37·3	49·	37·8	86·8	43·4
	48·9	37·4	48·7	37·7	86·4	43·2
	49·	37·2	48·	37·6	85·6	42·8
	49·5	35·1	48·7	35·9	84.6	42·3
			243·4	186·8	430·2	215·1
					Mean	43·02

Or

$T+D+Q=PS+1{\cdot}085$ div.

Balance weight 0·00966 gr. added.

T+D+Q

	Vibrations of Balance.				Sum.	Resting Point.
	Not taken.		Taken.			
	1. Highest.	2. Lowest.	3. Highest.	4. Lowest.		
(2)	55·9	50·1	55·4	50·2	105·6	52·8
	56·9	48·9	56·3	49·	105·3	52·65
	54·3	50·	54·1	50·2	104·3	52·15
	56·6	47·5	56·	48·	104·	52·
	64·4	39·	63·	40·8	103·8	51·9
			284·8	238·2	523·	261·5
					Mean	52·30

PS

	Vibrations of Balance.				Sum.	Resting Point.
	Not taken.		Taken.			
	1. Highest.	2. Lowest.	3. Highest.	4. Lowest.		
(3)	54·	50·1	53·7	50·1	103·8	51·9
	53·8	49·8	53·4	50·	103·4	51·7
	59·	44·1	58·	44·8	102·8	51·4
	53·	48·2	52·4	48·3	100·7	50·35
	52·2	48·	52·1	48·	100·1	50·05
			269·6	241·2	510·8	255·4
					Mean	51·08

Or

$T-D+Q=PS+0{\cdot}61$ div.

Appendix V.—*continued.*

Without balance weight.
T+D+Q

	Vibrations of Balance.				Sum.	Resting Point.
	Not taken.		Taken.			
	1. Highest.	2. Lowest.	3. Highest.	4. Lowest.		
(5)	49·3	40·	48·9	40·5	89·4	44·7
	51·8	38·5	50·9	39·	89·9	44·95
	54·6	34·	53·2	35·3	88·5	44·25
	49·5	38·9	49·	39·5	88·5	44·25
	49·	38·9	48·4	39·7	88·1	44·05
			250·4	194·	444·4	222·2
					Mean	44·44

Or (1) (5) T + D + Q = PS + 0·71 div.

Result in divisions of the index.

Mean of (1) (5) and (1) (4), T+D+Q=PS+0·8975 div.
Mean of all, T+D+Q=PS+0·75375 div.

To find the value of one division.

(1) (2)	(2) (5)	(3) (4)
52·30	52·30	51·08
45·19	44·44	43·02
7·11	7·86	8·06

Mean 7·485
Mean of all, 7·7725.

Therefore 0·00966 gr. = 7·7725 div., or 1 division = 0·00124 gr.

Hence T+D+Q=PS+0·00093 gr.

It has been already stated that T and the auxiliary platinum weights have been declared by Professor Miller to be of the same density, = 21·1661, which differs but little from that of PS, = 21·1572. In ordinary air PS displaces about 0·00020 grain of air more than 7,000 grains of platinum of the density of T.

Reduced to a vacuum, and taking the mean of the two comparisons of T+D+Q and PS (T+D=PS—0·64443 and 0·64440 respectively), it is shown that,—

	gr.		gr.
(*a*)	T+A+Q=PS—0·00473	or	6999·99527
(*b*)	T+B+Q=PS+0·00234	or	7000·00234
(*c*)	T+C+Q=PS+0·00236	or	7000·00236
(*d*)	T+D+Q=PS+0·00071	or	7000·00071
(*e*)	T+F+G+Q=PS+0·00127	or	7000·00127

and deducting Q=0·64509 gr.

	gr.
(*a*)	T+A=6999·35018
(*b*)	T+B=6999·35725
(*c*)	T+C=6999·35727
(*d*)	T+D=6999·35562
(*e*)	T+F+G=6999·35618

The differences between D and each of the other auxiliary weights have also been determined by actual comparisons. These differences, together with the differences according to their standard weight as ascertained above, and the mean differences of both, are as follows:—

Actual Comparisons.					Difference of Standard Weight as shown above.	Difference of actual Comparisons.	Mean Differences.
—	Date of Comparisons.	Number of Weighings.	Results of Weighing.	Value of One Division of Index Scale.			
	1868.		gr.	gr.	gr.	gr.	gr.
(*f*)	May 4	25	A=D−0·00563	0·00160	A=D−0·00544	+0·00019	A=D−0·00554
(*g*)	„ 5	25	B=D+0·00117	0·00151	B=D+0·00163	−0·00046	B=D+0·00140
(*h*)	„ 5	25	C=D+0·00102	0·00153	C=D+0·00165	−0·00063	C=D+0·00134
(*i*)	„ 5 and 26	50	F+G=D+0·00055	0·00161	F+G=D+0·00056	+0·00001	F+G=D+0·00055
	Total -	125					

In the two separate comparisons of F and G with D, D was found to be in excess 0·00091 gr. and 0·00018 gr. respectively, the mean being 0·00055 gr.

The greatest difference between any two of these results is thus seen to be considerably less than one-thousandth part of a grain in weight, and not to exceed one-third of one of the minute divisions of the index scale shown at p. 36.

Comparisons of all the auxiliary platinum standards.

In order to determine the absolute standard weight of T from the foregoing comparisons, as well as that of all the auxiliary platinum standards, the following additional comparisons have been made:—

—	Date of Comparison.	Number of Weighings.	Results of Weighings.	Value of 1 div. of Index.
	1868.		gr.	gr.
(*j*)	May 9 -	20	A+B+C+D+F=T−0·00087	0·00129
(*k*)	„ 28 -	15	G+H=F+0·00313	0·00165
(*l*)	„ 29 -	15	H+K=G+0·00145	0·00180
(*m*)	„ „ -	15	H+L=G−0·00084	0·00174
(*n*)	„ „ -	15	H+M=G+0·00131	0·00169
(*o*)	„ „ -	15	H+N=G+0·00137	0·00162
(*p*)	„ 30 -	15	K+L+M+N+R=H−0·00227	0·00073*
(*q*)	„ „ -	14	K+L+M+N+S=H−0·00182	0·00073*
(*r*)	„ „ -	15	R+S=K+0·00004	0·00085*
(*s*)	„ „ -	15	R+S=L+0·00164	0·00085*
(*t*)	„ „ -	15	R+S=M−0·00012	0·00081*
(*u*)	„ „ -	15	R+S=N−0·00088	0·00084*
(*v*)	June 3 -	15	R=S−0·00065	0·00086*
	Total -	199		

* With small balance No. 4, recently adjusted by Mr. Oertling.

Appendix V.—*continued.*

From all these comparisons it follows from substituting in each case the value of R+S:—

$$\begin{array}{rllll}
(r) & K & & & = R+S-0{\cdot}00004 \\
(s) & L & & & = R+S-0{\cdot}00164 \\
(t) & M & & & = R+S+0{\cdot}00012 \\
(u) & N & & & = R+S+0{\cdot}00088 \\
 & K+L+M+N & & & = 4\,(R+S)-0{\cdot}00068 \\
(p)\,(q) & 2\,H & =2\,(K+L+M+N)+R+S & +0{\cdot}00409 & = 9\,(R+S)+0{\cdot}00273 \\
 & 4\,H & & & = 18\,(R+S)+0{\cdot}00546 \\
(l)\,(m)\,(n)\,(o) & 4\,G & =4\,H+K+L+M+N & -0{\cdot}00329 & = 22\,(R+S)+0{\cdot}00149 \\
 & 2\,G & & & = 11\,(R+S)+0{\cdot}00075 \\
(k) & 4\,F & =4\,(G+H) & -0{\cdot}01252 & = 40\,(R+S)-0{\cdot}00557 \\
 & 2\,F & & & = 20\,(R+S)-0{\cdot}00278 \\
 & F & & & = 10\,(R+S)-0{\cdot}00139 \\
 & 4(F+G) & & & = 62\,(R+S)-0{\cdot}00408 \\
 & 2(F+G) & & & = 31\,(R+S)-0{\cdot}00204 \\
(f)\,(i) & A & =F+G & -0{\cdot}00609 & \\
 & 2\,A & =2\,(F+G) & -0{\cdot}01218 & = 31\,(R+S)-0{\cdot}01422 \\
(g)\,(i) & B & =F+G & +0{\cdot}00085 & \\
 & 2\,B & =2\,(F+G) & +0{\cdot}00170 & = 31\,(R+S)-0{\cdot}00034 \\
(h)\,(i) & C & =F+G & +0{\cdot}00079 & \\
 & 2\,C & =2\,(F+G) & +0{\cdot}00158 & = 31\,(R+S)-0{\cdot}00046 \\
(i) & D & =F+G & -0{\cdot}00055 & \\
 & 2\,D & =2\,(F+G) & -0{\cdot}00110 & = 31\,(R+S)-0{\cdot}00314 \\
 & A+B+C+D & =4\,(F+G) & -0{\cdot}00500 & = 62\,(R+S)-0{\cdot}00908 \\
(j) & T & =A+B+C+D+F & +0{\cdot}00087 & = 72\,(R+S)-0{\cdot}00960 \\
 & 2\,T & & & =144\,(R+S)-0{\cdot}01920
\end{array}$$

$$\begin{array}{ll}
(a)\ 2\,T+2\,A & =175\,(R+S)-0{\cdot}03342=13{,}998{\cdot}70028 \\
(b)\ 2\,T+2\,B & =175\,(R+S)-0{\cdot}01954=13{,}998{\cdot}71444 \\
(c)\ 2\,T+2\,C & =175\,(R+S)-0{\cdot}01966=13{,}998{\cdot}71446 \\
(d)\ 2\,T+2\,D & =175\,(R+S)-0{\cdot}02234=13{,}998{\cdot}71118 \\
(e)\ 2\,T+2\,(F+G) & =175\,(R+S)+0{\cdot}02124=13{,}998{\cdot}71228
\end{array}$$

$$\begin{array}{l}
(a)\ 175\,(R+S)=13{,}998{\cdot}73370 \\
(b)\ 175\,(R+S)=13{,}998{\cdot}73398 \\
(c)\ 175\,(R+S)=13{,}998{\cdot}73412 \\
(d)\ 175\,(R+S)=13{,}998{\cdot}73352 \\
(e)\ 175\,(R+S)=13{,}998{\cdot}73352
\end{array}$$

Mean of (*a*) (*b*) (*c*) (*d*) (*e*) $175\,(R+S)=13{,}998{\cdot}73377$
or $R+S=79{\cdot}99277$

In these computations the mean difference between A, B, C, and D respectively, with F and G, as shown at p. 40, has been taken.

In order to correct any error in the computations by which the actual weight of T is thus determined, the same result has been obtained by a separate computation from the same data, by substituting in each case the value of R.

$$\begin{array}{rlll}
(p)\,(q) & R+0{\cdot}00227\text{ gr.}=S-0{\cdot}00182\text{ gr.} & & \\
 & & S=R+0{\cdot}00045 & \\
 & & R+S & = 2\,R+0{\cdot}00045 \\
(r) & K & =R+S-0{\cdot}00004 & = 2\,R+0{\cdot}00041 \\
(s) & L & =R+S-0{\cdot}00164 & = 2\,R-0{\cdot}00119 \\
(t) & M & =R+S+0{\cdot}00012 & = 2\,R+0{\cdot}00057 \\
(u) & N & =R+S+0{\cdot}00088 & = 2\,R+0{\cdot}00133 \\
 & K+L+M+N & =4\,(R+S)-0{\cdot}00068 & = 8\,R+0{\cdot}00112 \\
(p)\,(q) & H & =K+L+M+N+R+0{\cdot}00227 & = 9\,R+0{\cdot}00339 \\
 & 4\,H & & = 36\,R+0{\cdot}01356 \\
(l)\,(m)\,(n)\,(o) & 4\,G & =4\,H+K+L+M+N-0{\cdot}00329 & = 44\,R+0{\cdot}01139 \\
 & G & & = 11\,R+0{\cdot}00285 \\
(k) & F & =G+H-0{\cdot}00313 & = 20\,R+0{\cdot}00311 \\
 & F+G & & = 31\,R+0{\cdot}00596 \\
(f)\,(i) & A & =F+G-0{\cdot}00609 & = 31\,R-0{\cdot}00013 \\
(g)\,(i) & B & =F+G+0{\cdot}00085 & = 31\,R+0{\cdot}00681 \\
(h)\,(i) & C & =F+G+0{\cdot}00079 & = 31\,R+0{\cdot}00675 \\
(i) & D & =F+G-0{\cdot}00055 & = 31\,R+0{\cdot}00541 \\
 & A+B+C+D & =4\,(F+G)-0{\cdot}00500 & =124\,R+0{\cdot}01884 \\
(j) & T & =A+B+C+D+F+0{\cdot}00087 & =144\,R+0{\cdot}02282
\end{array}$$

$$\begin{array}{ll}
(a)\ T+A & =175\,R+0{\cdot}02269=6999{\cdot}35014 \\
(b)\ T+B & =175\,R+0{\cdot}02963=6999{\cdot}35722 \\
(c)\ T+C & =175\,R+0{\cdot}02957=6999{\cdot}35723 \\
(d)\ T+D & =175\,R+0{\cdot}02823=6999{\cdot}35559 \\
(e)\ T+F+G & =175\,R+0{\cdot}02878=6999{\cdot}35614
\end{array}$$

$$\begin{array}{l}
(a)\ 175\,R=6999{\cdot}32745 \\
(b)\ 175\,R=6999{\cdot}32759 \\
(c)\ 175\,R=6999{\cdot}32766 \\
(d)\ 175\,R=6999{\cdot}32736 \\
(e)\ 175\,R=6999{\cdot}32736
\end{array}$$

$$\begin{array}{rl}
\text{Mean of }(a)\ (b)\ (c)\ (d)\ (e)\ 175\,R= & 6999{\cdot}32748 \\
R= & 39{\cdot}99616 \\
(p)\,(q)\ S= & 39{\cdot}99661 \\
R+S= & 79{\cdot}99277
\end{array}$$

Here $R+S=79{\cdot}99277$ gr., and $T=72\,(R+S)-0{\cdot}00960$ gr.$=5759{\cdot}46984$ gr.
And $R=39{\cdot}99616$ gr., and $T=144\,R+0{\cdot}02282$ gr.$=2759{\cdot}46986$ gr.

Hence the mean standard weight of T is found to be 5759·46985 grains.

Actual weight of T based by Prof. Miller on its relation to the lost standard.

The actual weight of T, in relation to the lost standard U, was dertermined by Professor Miller in 1844 from 122 comparisons of T with RS and Sp. (p. 819), the weight of each of these two platinum troy pounds having been taken from Schumacher's actual comparisons made with the lost standard in 1829 (p. 941), when 300 comparisons of Sp were made, and 140 comparisons of RS.

The density of the lost standard being assumed by Professor Miller to be the same as that of Vandome's troy pound of 1758, $V=S{\cdot}15084$, it was found (p. 820) that,—

In a vacuum $T=U-0{\cdot}52857$ gr., or$=5759{\cdot}47143$ gr.

In air ($t.=18{\cdot}7^\circ$, $b.=755{\cdot}64^{\text{mm.}}$)$=5759{\cdot}99255$ gr.

Appendix V.—*continued.*

This was the mean temperature and barometric pressure during the comparisons made in 1829 at Somerset House, when T displaced 0·32605 grains of air, and the lost standard was computed to displace 0·84717. Professor Miller used the same tables that had been adopted by Schumacher (p. 769), from Bessel's paper on the reductions of weighings, in the Astronomische Nachrichten, Vol. VII., p. 373.

And of the auxiliary platinum standards on T.

Actual weight of PS based on T and the auxiliary platinum standards.

The determination by Professor Miller in 1845, of the actual weight of the several auxiliary platinum standards, was based upon his weight of T in relation to the lost standard, viz., 5759·47143 gr. The same weight of T, and the corresponding relative weight of the platinum auxiliary standards, were taken by him in determining the actual weight of the restored standard PS, in relation to the lost standard. The mean result of 680 weighings of PS with T and A, B, C, and D separately (p. 861), was found to be that PS=7,000·00093 gr., of which the lost standard contained 5,760 gr. The probable error of this result was 0·000038 gr. (p. 941). But the probable error of T and the auxiliary weights was 0·000064 gr., therefore the probable error of PS was 0·000074 gr.

Process now reversed, and all weights based on PS.

The imperial standard pound PS is now declared by law to be the only standard measure of weight from which all other weights are to be derived, and to contain 7,000 grains. The process of 1845 is therefore to be reversed, and the actual weight of T and the auxiliary platinum weights must be based on PS.

Absolute weight of both T and PS proved to be unaltered since 1845.

The weight in a vacuum of T, in terms of the imperial standard, was shown by Professor Miller in 1856 (p. 945) to be 5759·47066. Its weight is now determined after a lapse of 22 years to be 5759·46985, being a difference of 0·00082 grains only. With so large a number of weighings of different standards, and the chances of accumulated errors of observations, an apparent difference of less than one-thousandth of a grain in the weight of T may at once be disregarded, more especially after the very close approximation of the comparisons of T and RS now made, with those made in 1845. In weighings in air, so small a difference is quite inappreciable for all practicable purposes. *It may, therefore, be taken as proved that the absolute weight not only of T, but also of PS, is unaltered since these standards were verified in* 1845, the final determination (p. 945) being—

In a vacuum $T = \frac{5760}{7000}$ PS—0·52934 gr.=5759·47066

In air ($t.=18{\cdot}7^\circ$, $b.=755{\cdot}64^{\text{mm.}}$)

By Professor Miller's tables T displaces - gr. 0·32604

5760 gr. of the brass commercial standard W displaces - - - - - - } 0·84796

Excess displaced by W 0·52192

Hence in the specified air; $T = \frac{5760}{7000} PS - 0{\cdot}00742$ gr.

$= 5759{\cdot}99258.$

Standard weight of T and the auxiliary platinum weights.

Following Professor Miller's example of basing the weight of the auxiliary platinum standards on the standard weight of T, and its relation to the imperial standard when weighed together with F + G, the result of the preceding comparisons, assuming the value of R = 39·996165 gr., will be as follows:—

Standard weight in a vacuum of T, and the auxiliary platinum standards.

As determined in 1868.	As determined by Professor Miller in 1845, including the Corrections of A, B, C, D, F, and G in 1856.	Difference in 1868.
Grains.	Grains.	Grains.
T=5759·47066	=5759·47143	+0·00077
A=1239·88100	=1239·89046	−0·00946
B=1239·88794	=1239·88758	+0·00035
C=1239·88788	=1239·88729	+0·00059
D=1239·88654	=1239·88619	+0·00035
F+G=1239·88709	=1239·88492	+0·00217
F= 799·92642	= 799·92769	−0·00127
G= 439·96067	= 439·96009	−0·00058
H= 359·96887	= 359·96614	+0·00273
K= 79·99274	= 79·99244	+0·00030
L= 79·99114	= 79·99112	+0·00002
M= 79·99290	= 79·99261	+0·00029
N= 79·99366	= 79·99336	+0·00030
R= 39·99616	= 39·99627	−0·00011
S= 39·99661	= 39·99631	+0·00030

COMPARISONS OF BULLION STANDARDS WITH T AND RS.

Comparisons of bullion standards with T and RS.

The following are the results of the weighings made for ascertaining the weight of some of the bullion standards by comparisons with T and with RS, for the purpose of determining the base of the verification of the bullion standards, and the final verification of the troy standards. Each bullion weight is designated by the number expressing its nominal value in troy ounces, and the letter *c* signifies its counterpoise; there are two 1 oz. weights, the first being distinguished as 1, the second as 1 oz.

—	Date of Comparison.	Number of Weighings.	Results of Weighings.		Value of One Division of the Index Scale.	Temp. of Centigrade Therm.	Bar. corrected and reduced to 0° C., or 32° Fahr..
	1868.			Grains.	Grains.	°	mm.
(1)	March 13 - -	20	10+1+1 oz.	= T−0·03331	0·00139	12·	766·253
(2)	„ 13 - -	20	10+1+1 oz.	= RS−0·03808	0·00141	12·18	766·177
(3)	„ 16 - -	20	10+2	= T−0·03001	0·00137	12·66	762·544
(4)	„ 16 - -	20	10+2	= RS−0·03503	0·00140	12·78	762·285
(5)	April 22, 23 -	40	5+4+2+1 mean of comparisons on two separate days.	= T−0·02968	0·00129	14·97	754·874
(6)	„ 27 - -	20	4+4c+2+2c	= T−0·00959	0·00130	13·33	763·666
	Total - -	140					

Reduced to a vacuum, these weighings are as follows:—

Ascertained weight of T = 5759·47066 gr.; RS = T + 0·00429 gr., or 5759·47495 gr.

gr. gr.

(1.) 10 + 1 + 1 oz. = T + 0·47555, or 5759·94621

(2.) 10 + 1 + 1 oz. = RS + 0·47085, or 5759·94580

(3.) 10 + 2 = T + 0·47514, or 5759·94580

(4.) 10 + 2 = RS + 0·47008, or 5759·94503

(5.) 5 + 4 + 2+1 = T + 0·46616, or 5759·93682

(6.) 4 + 4 *c* + 2+2*c* = T + 0·49508, or 5759·96574

In ordinary standard air (log. Δ = 7·07832 — 10) the weight of 12 oz. of the bullion standards displaces 0·81560 grains of air, the density of these weights being 8·466.

The actual density of the counterpoises of the bullion standards have not been ascertained; but as they are of similar metal to the bullion standards (of gun metal, though not electro-gilt, as the standards are), it is assumed that their density is the same as that of the bullion standards, and that they displace an equal amount of air. The question is of no great practical importance as affecting the only instance (*i*) in which a counterpoise has been used, since, even if the assumption were erroneous and the actual density of these counterpoises were no more than the average of brass and bronze weights as found by Professor Miller (p. 805), viz. 8·151, 12 ounces of which would displace 0·84673 grains of ordinary air, yet any error from assuming the density to be 8·466 would not amount to more than 0·00049 grains in excess of the weight of 4 + 4*c* + 2 + 2*c* as compared with T, and this would be little more than the probable error of a single observation.

The following are the results of the several weighings when reduced to ordinary standard air, and in terms of the Commercial Standard W., 5760 grains of which displace 0·84796 grains of air:—

gr.

(1.) 10 + 1 + 1 oz. = 5759·97857

(2.) 10 + 1 + 1 oz. = 5759·97816

(3.) 10 + 2 = 5759·97816

(4.) 10 + 2 = 5759·97739

(5.) 5 + 4 + 2 + 1 = 5759·96918

(6.) 4 + 4*c* + 2 — 2*c* = 5759·99810

Appendix V.—*continued.*

Mean result of direct comparisons.

The mean weight of the 10 oz. and 2 oz. bullion standards by the two direct comparisons with T and RS (3), (4), is thus shown to be 5759·97777 grains.

Comparisons of bullion standards, from 1 oz. to 10 oz.

In order to ascertain the mean weight of the two bullion standards of 10 oz. and 2 oz., both together and separately, from all the six preceding comparisons, the following comparisons among themselves of the bullion standards from 1 oz. to 10 oz., and their counterpoises, have been made.

COMPARISONS of BULLION STANDARDS from 1 oz. to 10 ozs.

—	Date of Comparison.	Number of Weighings.	Results of Weighings.		Value of One Division of the Index Scale.
	1868.				
(7)	April 28 - -	20	10=5+5c	−0·00019 gr.	0·00134 gr.
(8)	„ 23 and 24	40	10=5+4+1	+0·00867 „	0·00118 „
(9)	„ 21 - -	20	10=4+4c+2	−0·00847 „	0·00116 „
(10)	„ 28 - -	25	5=5c	−0·00992 „	0·00134 „
(11)	March 31 - -	20	5=4+1 4=4c	−0·00175 „ −0·01693 „	0·00173 „
(12)	„ 30 - -	20	4c=3+1 oz.	+0·01824 „	0·00178 „
(13)	„ 30 - -	20	4=3+1 oz.	+0·00131 „	0·00173 „
(14)	April 23 - -	20	4=2+2c	−0·01430 „	0·00135 „
(15)	March 31 - -	20	4=2+1+1 oz.	+0·00004 „	0·00177 „
(16)	„ 26 and 28	40	3=2+1	−0·00111 „	0·00180 „
(17)	„ 24 and 26	40	3=2+1 oz.	−0·00046 „	0·00182 „
(18)	Feb. 28 - -	20	2=2c	−0·01045 „	0·00368 „*
(19)	„ 28 and 29	48	2=1+1 oz.	−0·00156 „	0·00540 „*
(20)	„ 28 - -	25	2c=1+1 oz.	+0·01145 „	0·00410 „*
(21)	March 23 and 26	50	1=1 oz.	+0·00081 „	0·00199 „
		428			

From these equations the following results of the preceding six comparisons are obtained by the process of substitution.

Determination of standard weight of 10 oz. and 2 oz. together:

To find the Mean Standard Weight of the 10 *oz. and* 2 *oz. Bullion Standards together.*

			gr.
(1)	by substituting (19)	10 + 2 =	5759·97701
(2)	„ (19)	10 + 2 =	5759·97660
(3)	direct comparison, as before	10 + 2 =	5759·97816
(4)	„ „	10 + 2 =	5759·97739
(5)	by substituting (8)	10 + 2 =	5759·97785
(6)	„ (9) (18)	10 + 2 =	5759·97918

∴ Mean weight of 10 oz. + 2 oz. = 5759·97770

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* These three weighings were made with the smallest balance No. 4, which required adjustment; the others were made with the larger balance No. 3, which was then the most sensitive.

and of their weight separately.

To find the Mean Standard Weight of the 2 *oz. Bullion Standard.*

			gr.
(1)	by substituting	(9) (12) (13) (14) (18) (19) 2 oz. =	959·99604
(2)		(9) (12) (13) (14) (18) (19) 2 oz. =	959·99598
(3)		(9) (12) (13) (14) (18) 2 oz. =	959·99623
(4)		(9) (12) (13) (14) (18) 2 oz. =	959·99610
(5)		(11) (14) (18) (19) (21) 2 oz. =	959·99629
(6)		(12) (13) (14) (18) 2 oz. =	959·99640

∴ Mean weight of 2 oz. = 959·99618

and consequently mean weight of 10 oz. = 4799·98152

∴ Mean weight of 10 + 2 oz. = 5759·97770

The standard weight in air of the 10 oz. and 2 oz. bullion standards, as determined by Professor Miller in 1855, was—

	Difference in 1868.
10 oz. = 4800·00042 gr. -	− 0·01890 gr.
2 oz. = 959·99947 - -	− 0·00329
10 + 2 oz. = 5759·99989 - -	− 0·02219

It should be remembered that these bullion standards were deposited at the Exchequer in 1855, and have been in use during 13 years.

Consequent correction o the weight of the official troy pound, based on these two standards.

It has been stated in Appendix IV., p. 26, with reference to the verification of the official troy standards, that their weight in relation to the imperial standard has been ascertained by comparison with the two bullion standards of 10 oz. and 2 oz., taking these two standards together to be 0·00011 too light, according to Professor Miller's determination in 1855, and that the troy pound was then shown to be 0·13171 grain too heavy. The two bullion standards being now found to be 0·02219 grain lighter than in 1855, the difference in excess of the troy pound would appear to be reduced to 0·10952 gr. heavier than 5760 grs. of the imperial standard.

Standard weight of troy pound also checked by comparison wit O.

Before however finally accepting this last result, recourse has been made to a mode of checking it, and of determining the standard weight of the official troy pound by a distinct process. Amongst the standards deposited at the Standards Department last year, after the comparisons of the troy standards were completed, was Alchorne's troy pound of 1758, designated as O, and said to be the original weight from which the lost standard was made for the House of Commons. This is the only troy pound made of brass in the Standards Department, the density of which has been determined.

In 1853 Professor Miller found its density to be 8·40036 (p. 803), and that in a vacuum O = T + 0·3595 grs. In standard air (*t.* = 18·7, *b.* = 755·64), O = T − 0·1363 grs., and its weight = 5759·85625 grs. of the lost standard.

Comparison of O with T.

The following is the result of a direct comparison of O with T:—

Date of Comparison.	Number of Weighings.	Results of Weighings.	Value of One Division.	Mean Temperature.	Bar. corrected to 0° C.
1868, May 27 - -	25	O=T+0·03021 gr.	0·00137 gr.	63·3° F.=17·39° C.	30·119 in.=765·01 mm.

O displaced 0·83632 grain of air, and T 0·33174, whence in a vacuum O = T + 0·53477, or O = 5760·00543 grains.

In standard air (*t.* = 18·7, *b.* = 755·64) O displaces 0·82199 grains of air, and 5760 gr. of W, the brass commercial standard, 0·84796, hence O = 5760·03140 grs.

And of official troy pound with O and with 10 + 2 oz. bullion standards.

In the following additional comparisons, no reduction is required for the weight of air displaced by the several brass and bronze standards, the density of O and of the bullion standards not differing materially, and that of the official troy pound never having been determined. As much additional experience in weighing has been gained by the officers of the Department, since the comparison in 1867 of the official troy pound with the 10 oz. and 2 oz. bullion standards, and as these standards have since had an additional twelve months' wear and tear, it has been thought desirable to have a new and more accurate comparison made between them, with the improved arrangements of balance No. 3.

Taking 0 = 5760·03140 gr.
10 + 2 oz. bullion standards = 5759·97770 gr.

Date of Comparison.	Number of Weighings.	Results of Weighings.	Value of One Division.	Result in Standard Weight.
			gr.	gr.
1868, May 27	25	Official troy lb.=0+0·07446 gr.	0·00130	5760·10586
„ April 30	25	„ „ =10+2 oz.+0·12817	0·00140	5760·10587

In the comparison of the official troy pound with the 10 + 2 oz. in 1867 (Appendix IV., p. 29), the troy lb. was found = 10 + 2 oz. + 0·13182. The more accurate comparison now made should be substituted for it.

The mean standard weight in air of the official troy standard pound is thus shown to be 5760·10586 grains, and the following exact relations of the official standards of troy weight to the imperial standard should be substituted for those stated in Appendix IV.

Appendix V.—*continued.*

Exact relations of the official standards of troy weight to the imperial standard.

Final determination of standard weight of official troy standards.

Denominations of Official Standards of Troy Weight.		Weight provisionally determined in 1867, as stated in App. IV., p. 26.	Standard Weight now determined.		Difference of weight now determined as compared with the results in 1867.
Troy.		Grains.	Grains.	Grains.	Grains.
1 lb.	- -	5760·13171	5760·10586,	or 0·10586 too heavy	—0·02585
6 oz.	- -	2879·99425	2879·98132	„ 0·01868 too light	—0·01293
3 „	- -	1440·00063	1439·99416	„ 0·00584 „	—0·00647
2 „	- -	959·99812	959·99381	„ 0·00619 „	—0·00431
1 „	- -	479·99727	479·99511	„ 0·00489 „	—0·00216
10 dwt.	- -	239·99340	239·99232	„ 0·00768 „	—0·00108
5 „	- -	119·99833	119·99778	„ 0·00222 „	—0·00055
3 „	- -	71·99754	71·99721	„ 0·00279 „	—0·00033
2 „	- -	47·99801	47·99779	„ 0·00221 „	—0·00022
1 „	- -	24·00150	24·00139	„ 0·00139 too heavy.	—0·00011
12 gr.	- -	12·00019	12·00013	„ 0·00013 „	—0·00006
6 „	- -	5·99722	5·99719	„ 0·00281 too light	—0·00003
3 „	- -	2·99627	2·99626	„ 0·00374 „	—0·00001
2 „	- -	1·99653	1·99652	„ 0·00348 „	—0·00001
1 „	- -	0·99965	0·99965	„ 0·00035 „	—

The completion of the reverification of the bullion standards will be shown in a continuation of this paper.

H. W. CHISHOLM,
Warden.

Standards Department, 29th June 1868.

PART II.—FURTHER REVERIFICATION of the OFFICIAL STANDARD BULLION WEIGHTS, and of other OFFICIAL STANDARD WEIGHTS.

CONTENTS.

Page

Reverification of bullion standards, 1 oz. to 0·001 oz. inclusive:

- Comparisons of these standards with each other - 47
- Mode of deducing results - - - - 48
- Results of preceding comparisons - - - „
- Check of accuracy by direct comparisons - - 49

Method of comparison of larger bullion weights, with gilt gun metal lbs. and other auxiliary standards - - „
Reverification of gilt gun metal lbs., No. 31 to No. 34 - „
Use of Barrow's balance, with improved arrangements - 50
Reverification of bronze grain weights, O to W - - „
Verification of gilt gun metal weights of 4,000, 2,000, and 1,000 grains - - - - - - - - 51

Reverification of larger bullion standards, 20 oz. to 500 oz.:

- Comparisons with each other - - - 52
- Results of these comparisons - - - - „
- Check by comparison with other standard weights - 53

Page

Standard weight of bullion standards as now ascertained - 53
Reverification of 10 lbs. weights, standard of gallon measure - - - - - - - 54
Verification of the Pyx troy weights - - - „
Reverification of standard 62·321 lbs. weight, the base of the unit of gas measure - - - - 55
Its comparison with bullion and avoirdupois standards - „
Apparent increase in weight since 1859 - - - 56
Comparison with its three brass copies - - - „
Unsatisfactory results - - - - - 57
Verification of decimal grain weights - - - „
Duplicate sets of all the official standards recommended - 59

Reverification of Bullion Standards, 1 oz. to 0·001 *oz.*

Comparison of bullion standards, 1 oz. to 0·001 oz. with each other.

In continuation of the comparison and reverification of the official Standard Bullion Weights, the following comparisons of the smaller Bullion Standards have been made in the Department.

From further experience, I have now come to the conclusion that it is more expedient to make 15 weighings for each comparison, instead of 20, as shown in detail at p. 27; that is to say, three weighings in each series without changing the weights, instead of four. It will be seen that the value of one division of the index has been taken, and is shown for each comparison.

Comparisons of Bullion Standards from 1 *oz. to* 0·001 *oz.*

No.	Date of Comparison.		Number of Weighings.	Results of Weighings.				Value of One Division of Index Scale.
	1868.					Grains.		Grains.
(22)	Sept.	4	15	1 oz.	♎ 0·5 + 0·4 + 0·1	+ 0·01483		0·00167
(23)	„	„	15	1 oz.	♎ 0·5 + 0·3 + 0·2	+ 0·00981		0·00163
(24)	„	5	15	0·5	♎ 0·4 + 0·1	+ 0·00185		0·00161
(25)	„	4	15	0·5	♎ 0·3 + 0·2	− 0·00394		0·00169
(26)	„	9	15	0·4 + 0·1	♎ 0·3 + 0·2	− 0·00541	− 0·00560	0·00170
(27)	„	10	15	0·4 + 0·1	♎ 0·3 + 0·2	− 0·00580		0·00168
(28)	„	5	15	0·4	♎ 0·3 + 0·1	− 0·00137		0·00176
(29)	„	„	15	0·4	♎ 0·2 + 0·1 + 0·1*c*	− 0·00400	− 0·00377	0·00168
(30)	„	„	15	0·4	♎ 0·2 + 0·1 + 0·1*c*	− 0·00355		0·00163
(31)	„	„	15	0·3	♎ 0·2 + 0·1	− 0·00091		0·00178
(32)	„	9	15	0·3	♎ 0·2 + 0·1*c*	− 0·00290		0·00177
(33)	„	„	15	0·2	♎ 0·1 + 0·1*c*	+ 0·00190		0·00175

Appendix V.—*continued.*

No.	Date of Comparison.	Number of Weighings.	Results of Weighings.				Value of One Division of Index Scale.
	1868.				Grains.		Grains.
(34)	Sept. 9	15	0·1	≏0·1*c*	−0·00228		0·00175
(35)	" "	15	0·1	≏0·05+0·04+0·01	+0·01010		0·00089
(36)	" 11	15	0·1	≏0·05+0·03+0·02	+0·00638		0·00088
(37)	" "	15	0·05	≏0·04+0·01	+0·00211		0·00088
(38)	" "	15	0·05	≏0·03+0·02	−0·00153		0·00090
(39)	" 29	15	0·04+0·01	≏0·03+0·02	−0·00409		0·00091
(40)	" 12	15	0·04	≏0·02+0·01+0·01*c*	−0·00252		0·00088
(41)	" "	15	0·04	≏0·03+0·01	+0·00050		0·00088
(42)	" "	15	0·03	≏0·02+0·01	−0·00007		0·00089
(43)	" "	15	0·03	≏0·02+0·01*c*	−0·00305		0·00090
(44)	" "	15	0·02	≏0·01+0·01*c*	+0·00140		0·00090
(45)	" 14	15	0·01	≏0·005+0·004+0·001	−0·00214		0·00090
(46)	" 15	15	0·01	≏0·005+0·003+0·002	−0·00268	−0·00264	0·00089
(47)	" "	15	0·01	≏0·005+0·003+0·002	−0·00260		0·00088
(48)	" 12	15	0·01	≏0·01*c*	−0·00286		0·00090
(49)	" 15	15	0·005	≏0·004+0·001	−0·00025		0·00092
(50)	" "	15	0·005	≏0·003+0·002	−0·00056		0·00091
(51)	" 29	15	0·004+0·001	≏0·003+0·002	−0·00062		0·00089
(52)	" 15	15	0·004	≏0·003+0·001	−0·00050		0·00090
(53)	" "	15	0·004	≏0·002+0·001+0·001*c*	+0·00038		0·00089
(54)	" 16	15	0·003	≏0·002+0·001*c*	+0·00093	+0·00091	0·00088
(55)	" 11	15	0·003	≏0·002+0·001*c*	+0·00089		0·00090
(56)	" 16	15	0·002	≏0·001+0·001*c*	+0·00075	+0·00073	0·00089
(57)	" "	15	0·002	≏0·001+0·001*c*	+0·00072		0·00089
(58)	" "	15	0·001	≏0·001*c*	+0·00063		0·00090
	Total	555	weighings.				

From these equations, as well as from those stated at p. 43, and numbered from (7) to (21), the value of each weight has been obtained by the process of substitution; the actual weight of the two bullion standards of 10 oz. and 2 oz., upon which the results are based, having been determined, at p. 43, to be,—

gr.
(*a*) 10 oz. Bullion weight = 4799·98152
(*b*) 2 oz. " = 959·99618

Mode of deducing results.

The following method has been adopted for deducing the value of each Standard weight, and is applicable to each decimal series:

1 oz. = 479·99846 gr.

(22) 0·5 + 0·4 + 0·1 ≏ 1 oz. − 0·01483 gr.
(24) 0·5 ≏ 0·4 + 0·1 + 0·00185

Whence 2 (0·5) = 1 oz. − 0·01298
or 479·98548

∴ 0·5 = 239·99274

(23) 0·5 + 0·3 + 0·2 ≏ 1 oz. − 0·00981
(25) 0·5 ≏ 0·3 + 0·2 − 0·00394

Whence 2 (0·5) = 1 oz. − 0·01375
or 479·98471

∴ 0·5 = 239·99235

∴ 0·5 (Mean) = 239·99254

(33) 0·1 + 0·1c ≏ 0·2 − 0·00190
(34) 0·1 ≏ 0·1c − 0·00228

∴ 2 (0·1) = 0·2 − 0·00418
(31) 0·2 + 0·1 ≏ 0·3 + 0·00091

∴ 3 (0·1) = 0·3 − 0·00327
(28) 0·3 + 0·1 ≏ 0·4 + 0·00137

∴ 4 (0·1) = 0·4 − 0·00190
(24) 0·4 × 0·1 ≏ 0·5 − 0·00185

∴ 5 (0·1) = 0·5 = 0·00375
or 239·98879

Whence 0·1 = 47·99776
0·2 = 95·99542 + 0·00418 = 95·99960
0·3 = 143·99328 + 0·00327 = 143·99655
0·4 = 191·99103 + 0·00190 = 91·99293

Results of preceding comparisons.

Results o preceding comparis

		oz.	gr.
	From (7) (10) (*a*)	5	= 2399·98588
	(8) (11) (*a*)	5	= 2399·98553
(*c*)	Mean	5	= 2399·98571
(*d*)	(19) (21) (*b*)	1	= 479·99927
(*e*)		and 1 oz.	= 479·99846
	(8) (*a*) (*c*) (*d*)	4	= 1919·98784
	(9) (12) (13) (*a*)	4	= 1919·98843
(*f*)	Mean	4	= 1919·98813
	(16) (*d*)	3	= 1439·99433
	(17) (*e*)	3	= 1439·99417
(*g*)	Mean	3	= 1439·99425
	(22) (24) (*e*)	0·5	= 239·99274
	(23) (25) (61)	0·5	= 239·99235
(*h*)	Mean	0·5	= 239·99254
(*i*)	(24) (28) (31) (33) (34) (*h*)	0·1	= 47·99776
	(23) (25) (28) (31) (33) (34) (*h*)	0·1	= 47·99776
(*k*)		0·2	= 95·99960
(*l*)		0·3	= 143·99655
(*m*)		0·4	= 191·99293
	(35) (37) (*i*)	0·05	= 23·99488
	(36) (38) (*i*)	0·05	= 23·99492
(*n*)	Mean	0·5	= 23·99490
(*o*)	(37) (40) (44) (48) (*n*)	0·04	= 19·19515
(*p*)		0·02	= 9·59954
(*q*)		0·01	= 4·79764
(*r*)	(41) (*o*) (*q*)	0·03	= 14·39701
	(45) (49) (*q*)	0·005	= 2·39976
	(46) (47) (50) (*q*)	0·005	= 2·39986
(*s*)	Mean	0·005	= 2·39981

Appendix V.—*continued.*

(*t*) (49) (53) (56) (57) (58) (*s*) 0·004 = 1·91973
(*u*) 0·001 = 0·48033
(*v*) (52) (*t*) (*u*) 0·003 = 1·43990
(*w*) (53) (56) (*t*) 0·002 = 0·96003

Check of accuracy by direct comparisons.

During the process of computation, these results have from time to time been checked by direct comparisons of the several standard weights; for example,—

		gr.
(*k*) (*l*)	0·3 oz. + 0·2 oz.	=239·99615
(*i*) (*m*)	0·4 oz. + 0·1 oz.	=239·99069

Whence 0·3 oz. + 0·2 oz. = 0·4 oz. + 0·1 oz. } +0·00546
By direct comparison (26) (27) 0·3 oz. +0·2 oz. = 0·4 oz. + 0·1 oz. } +0·00560

But a more decisive test of the accuracy of the results of all these weighings has been afforded by the following method:—

	Nominal Weight.		Weight now determined.
	oz.	gr.	gr.
Official standard bullion	1·	=480	479·99846
	0·4	=192	191·99293
	0·3	=144	143·99655
	0·2	= 96	95·99960
	0·04	= 19·2	19·19515
	0·03	= 14·4	14·39701
	0·02	= 9·6	9·59954
	0·004	= 1·92	1·91973
	0·003	= 1·44	1·43990
	0·002	= 0·96	0·96003
	0·001	= 0·48	0·48033
Total	2·	=960·	959·97923
And	2·	=	959·99617

Whence standard 2 oz. = 1 oz. and smaller weights - - - - - - + 0·01694
By direct comparison on 10th October as the result of 15 weighings, Standard 2 oz. = 1 oz. and smaller weights - - + 0·01695

This last result appears to be a satisfactory proof of the accuracy of all these weighings and computations.

Verification of 0·025 oz.

Amongst the official bullion standards there is a weight of 0·025 oz. (= 12 grs.), but this denomination is never included in a set of copies of the bullion standards verified in the Department. It has consequently never been used, except for departmental purposes, since it was deposited with the other bullion standards in 1855. Its standard weight is now ascertained to be—

(59) 1868, Nov. 5, 0·025=0·02=0·005 —0·00056 div. (val. 1 div.=0·00089 gr.) } or=11·99846 gr.

Method of comparison of larger bullion weights, with gilt gun-metal pounds and other auxiliary standards.

For the comparison and verification of the official standard bullion weights above 10 oz. up to 500 oz., a similar method has been employed to that used by Professor Miller in 1855, as stated at p. 939 of his Paper upon the Construction of the New Standard Pound and Secondary Standards. The series of official standard gilt gun-metal pounds has now been used in the comparisons, together with the following grain weights made of gilt gun-metal, being duplicates of similar weights made for Professor Miller (see Report, p. 939); these grain weights having lately been furnished to the Department by Messrs. Oertling:—

A gilt gun-metal weight of 4,000 grains.
„ „ 2,000 „
„ „ 1,000 „ B

Another set of nine auxiliary weights, increasing from 100 gr. to 12,800 gr. in a progressive binary series, including a duplicate weight of 100 grains, has also been used. They are made of bronze, for which log Δ = 0·92260, and are mentioned at p. 940 of Professor Miller's Paper, as having been used by him in the original verification of the bullion standards. These bronze grain weights accompanied Barrow's balance, when it was transferred by Professor Miller to the Standards Department. They are as follows:—

O = 100 gr. nominal weight.
P = 100 „ „
Q = 200 „ „
R = 400 „ „
S = 800 „ „
T = 1600 „ „
U = 3200 „ „
V = 6400 „ „
W = 12800 „ „

The comparison and reverification of all these auxiliary standard weights were first proceeded with.

It has been stated in Appendix IV., p. 24, that the reverification of the official standards of avoirdupois weight was based on the two standard gilt gun-metal pounds, Nos. 31 and 34, the weights of which in standard air were determined by Professor Miller, in 1855, to be respectively 0·00080 gr., too heavy, and 0·00089 gr., too light, the difference between them thus being 0·00169 gr. From an official comparison of these two standard weights with each other, made in January 1867, and detailed at p. 24 (Appendix IV.), it was found that No. 31 = No. 34 + 0·00168 gr. It was accordingly assumed that these two weights were unaltered, they having been very little used since their deposit in this Department.

Subsequently to this comparison, No. 31 was transmitted to the Paris Exhibition, and two more gilt gun-metal pounds have been transferred by the Astronomer Royal to the Department, No. 32 and No. 33, the weights of which in standard air Professor Miller determined to be respectively 0·00304 gr., too heavy, and 0·00063 gr., too light.

Reverification of four gilt gun-metal pounds, No. 31 to No. 34.

A reverification of these four auxiliary standard pounds, by comparison with the Imperial Standard, has now been made.

COMPARISONS of GILT GUN-METAL POUNDS, No. 31 and No. 34, with the IMPERIAL STANDARD.

No.	Date of Comparison.	Mean Temp.	Bar. corrected.	Number of Weighings.	Results of Weighings.	Value of 1 Division of Index.
	1868.	° C.	mm.		Grains.	Grains.
(1)	May 12	15°·94	758·56	20	No. 31+Q ≏ PS−0·01236	0·00144
(2)	„ 26	17°·26	761·12	25	No. 31+Q ≏ PS−0·01047	0·00140
(3)	Oct. 14	15°·5	765·11	15	No. 31+Q ≏ PS−0·02031	0·00150
				60		
(4)	May 11	16°	758·31	20	No. 34+Q ≏ PS−0·00300	0·00137
(5)	„ 18	17°·22	764·53	25	No. 34+Q ≏ PS−0·00322	0·00146
(6)	Oct. 15	15°·13	758·682	15	No. 34+Q ≏ PS−0·00316	0·00141
				60		

Reduced to a vacuum, the weighings are as follows:—

(1) No. 31+Q ≏ PS+0·58511 gr.
(2) No. 31+Q ≏ PS+0·58700 „
(3) No. 31+Q ≏ PS+0·58318 „

Mean No. 31+Q ≏ PS+0·58510 or =7000·58510

(4) No. 34+Q ≏ PS+0·59411 gr.
(5) No. 34+Q ≏ PS+0·59611 „
(6) No. 34+Q ≏ PS+0·59615 „

Mean No. 34+Q ≏ PS+0·59546 or =7000·59546

Deducting Q=0·64509 gr. in standard air:—

—	In a Vacuum.	Weight of Standard Air displaced			Weight in Standard Air, in terms of the Commercial Standard.
		By Commercial Standard.	By Gilt Gun-metal Pound.	Excess by Commercial Standard.	
	Grains.	Grains.	Grains.	Grains.	Grains.
No. 31=	6999·94001	1·03051	0·98555	0·04496	6999·98497
No. 34=	6999·95037	1·03051	0·98552	0·04499	6999·99536

Whence No. 31 = No. 34 − 0·01039 gr.

This result has been checked by the following direct comparisons of the two pounds, Nos. 31 and 34:—

No.	Date of Comparison.	Number of Weighings.	Results of Weighings.	Value of 1 Division of Index.
	1868.		Grains.	Grains.
(7)	May 4 -	20	No. 31 ≏ No. 34−0·01053	0·00134
(8)	Oct. 30 -	15	No. 31 ≏ No. 34−0·01166	0·00152

Mean No. 31 ≏ No. 34—0·01109 gr.

Allowing for the difference of the weight of air displaced by No. 31 = + 0·00003 gr., the difference between these two results is 0·00067 gr., or a little more than one-third of a division of the index scale of balance No. 3, as shown p. 39.

Appendix V.—*continued.*

The other two gilt gun-metal official standard pounds, No. 32 and No. 33, have not been directly compared with the Imperial Standard, but the following comparisons have been made with Nos. 31 and 34:—

No.	Date of Comparison.	Number of Weighings.	Results of Weighings.	Value of One Division of Index.	Standard Weight in Air.
	1868.		Grains.	Grains.	Grains.
(7)	October 17 -	15	No. 32 $\bumpeq$ No. 31 + 0·01767	0·00139	or = 7000·00264
(8)	„ 17 -	15	No. 32 $\bumpeq$ No. 34 + 0·00894	0·00147	„ = 7000·00430
		30			Mean 7000·00347
(9)	„ 20 -	15	No. 33 $\bumpeq$ No. 31 + 0·01412	0·00145	or = 6999·99909
(10)	„ 17 -	15	No. 33 $\bumpeq$ No. 34 + 0·00318	0·00142	„ = 6999·99854
		30			Mean 6999·99882

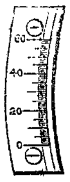
The following table shows the standard weight in air of these four gilt gun-metal standards, as now ascertained compared with their weight as determined by Professor Miller, on their original verification in 1855, together with their difference in weight:—

—	Weight now ascertained.	By Professor Miller in 1855 (Report p. 946).	Difference of Weight as now ascertained.
	Grains.	Grains.	Grains.
Gilt gun-metal lb., No. 31	= 6999·98497 or −0·01503	7000·00080 or +0·00080	−0·01593
„ 32	= 7000·00347 „ +0·00347	7000·00304 „ +0·00304	+0·00043
„ 33	= 6999·99882 „ −0·00118	6999·99937 „ −0·00063	−0·00055
„ 34	= 6999·99536 „ −0·00464	6999·99911 „ −0·00089	−0·00375

Nos. 32 and 33 have been very little used since their original verification, and Nos. 31 and 34 have been more frequently used in the official comparisons, No. 31 having also been lent for the Paris Exhibition, and perhaps has been a little rubbed during the transport. The greater amount of difference in these two last standard weights is therefore readily accounted for.

Use of Barrow's balance, with improved arrangements.

Many of the subsequent comparisons of the auxiliary standards were made with Barrow's balance, mentioned at page 46 of this Paper, Mr. Oertling having completed the requisite improvements according to Professor Miller's directions, and put the balance into thorough order. A new index has been fixed to each end of the beam, made of thin and nearly transparent ivory, with a scale, marked from 0 to 60 degrees, and about half an inch in length, being of the following form and size:—



Left-hand Index Scale of Barrow's balance.

The two microscopes, with single horizontal wires, are fixed to the glass case of the balance so that each of these scales can be viewed at the same time, if two observers are engaged in noting the oscillations. When there is sufficient daylight it is thrown upon the ivory scales by reflectors properly placed for that purpose; if artificial light is required, the image of the flame of a candle, placed at some distance from the balance case, can be cast upon the back of the ivory scale by means of a lens. A double glass screen is interposed between the observers and the balance. Moveable light brass pans of different sizes, two of each size as nearly as possible of the same weight, have been furnished for carrying the weights under comparison. A sliding rod, with a hook to transfer the pans carrying the weights from one side of the beam to the other, is fitted inside the case, the pans being placed on the hooks by means of a rod with a hook at the end introduced through a small hole at each end of the case. There is also a frame fixed to the stand of the balance to carry two thermometers, the bulbs of which can be adjusted to the height of the centre of gravity of the weight in each pan.

This balance is found very convenient for use when several weights are placed together in one of the pans, which can then be easily and quickly transferred from one side of the beam to the other.

REVERIFICATION OF BRONZE GRAIN WEIGHTS, O TO W.

Reverification of bronze g weights, O to W.

The comparisons of these grain weights were made both with Barrow's balance and Oertling's balance, No. 3, the value of one division of the indexes of these two balances being nearly identical. The weighings have, therefore, served to test the relative merits of the two balances.

In weighing with Barrow's balance, the two pans used are respectively denoted by X and Y.

One observer only was employed, who used the right-hand index scale, the daylight falling better upon it. It is read from 0 at the top to 60 at the bottom; the actual difference between the weights compared is, therefore, the reverse of the apparent difference, according to the noted readings in the form adopted in the Department, and adapted for observations of the left-hand index.

Gauss' method of weighing was used in two ways (A) and (B), viz.,

P and Q being the weights under comparison,—

(A) (1) $P+X \bumpeq Q+Y$ three readings taken.
(2) $Q+Y \bumpeq P+X$ „
(3) $P+Y \bumpeq Q+X$ „
(4) $Q+X \bumpeq P+Y$ „
Result = Mean of (1)+(2) and (3)+(4).
(5) For value of a division, balance weight added to (4).

(B) The comparisons stated in (A) (1, 2, 3, 4, and 5) were first made without changing the weights in the pans, P being in X, and Q in Y. A second set of comparisons (1, 2, 3, 4, and 5) was then made, after changing the weights in the pan, P being in Y, and Q in X. The mean of the two results was taken.

It was found that (A) gave the same result as (B), and occupied less time. The weighings (B) were therefore discontinued after the first four comparisons.

Appendix V.—*continued.*

COMPARISON OF BRONZE GRAIN WEIGHTS.

No. of Comparison.	Date of Comparison.	Number of Weighings.	Results of Weighings.	Difference.	Mean Difference.	Balance, and Method used.	Value of One Division of Index.	Mean Temp.	Bar. corrected to 0° C.
	1868.			Grains.	Grains.		Grains.		
1	Oct. 31 -	15	$P \bumpeq O$	−0·00007	±0·00000	Barrow (A.)	0·00173		
2	„ 31 -	30		+0·00009		„ (B.)	0·00173		
3	„ 31 -	15		−0·00002		Oertling No. 3	0·00174		
4	Nov. 2 -	15	$Q \bumpeq O+P$	−0·00436	−0·00420	Barrow (A.)	0·00175		
5	„ 2 -	30		−0·00424		„ (B.)	0·00169		
6	„ 4 -	15		−0·00400		Oertling No. 3	0·00166		
7	„ 3 -	15	$R \bumpeq O+P+Q$	+0·01222	+0·01192	Barrow (A.)	0·00173		
8	„ 3 -	30		+0·01183		„ (B.)	0·00169		
9	„ 3 -	15		+0·01194		Oertling, No. 3	0·00169		
10	Oct. 29 -	15	$S \bumpeq O+P+Q+R$	−0·00238	−0·00246	Barrow (A.)	0·00143		
11	„ 31 -	30		−0·00234		„ (B.)	0·00172		
12	„ 29 -	15		−0·00267		Oertling, No. 3	0·00159		
13	„ 29 -	15	$T \bumpeq O+P+Q+R+S$	−0·02239	−0·02254	Barrow (A.)	0·00134		
14	„ 29 -	15		−0·02269		Oertling, No. 3	0·00153		
15	„ 30 -	15	$U \bumpeq O+P+Q \times R+S+T$	−0·02285	−0·02258	Barrow (A.)	0·00137		
16	„ 30 -	15		−0·02232		Oertling, No. 3	0·00145		
17	Nov. 4 -	15	$V \bumpeq O \times P+Q+R+S+T+U$	+0·01512		„ „	0·00134		
18	„ 5 -	15	$W \bumpeq O \times P+Q+R+S+T+U+V$	−0·02611		„ „	0·00286		
19	„ 4 -	15	Plat. lb. $T \bumpeq P+S+T+U+$ 0·1 oz.+0·025 oz.	−0·00537		„ „	0·00137	14·61° C.	29·7028 in.
20	„ 5 -	15		−0·00807		„ „	0·00144	15·2°	29·6016
Total number of weighings		360							

In comparison No. 19, T displaced 0·33057 grains of air, and the bronze weights 0·83649.

Whence in vacuo $P+S+T+U+$ Bullion 0·1 oz.+0·025 oz. - $\doteq T+0 \cdot 51129$ gr.

In No. 20, T displaced 0·32868 grs. of air, and the bronze weights 0·83173.

Whence *in vacuo* $P+S+T+U+$ 0·1 oz.+0·025 oz. - - $\doteq T+0 \cdot 51112$ gr.

Mean - - - $\doteq T+0 \cdot 51120$ gr.
or 5759·98166 gr.

And (deducting 0·1 oz.+0·025 oz.=59·92655 gr.) $P+S+T+U=5699 \cdot 98531$ gr.

In standard air (log. $\Delta = 7 \cdot 07832-10$) $P+S+T+U$ displace 0·82520 grains of air, and $\frac{5700}{7000}$ of the commercial standard displace $\frac{5000}{7000}$ of 1·03051 gr. or 0·83911 gr.

Therefore $P+S+T+U=5699 \cdot 99922$ gr.

The results of the comparisons, 1 to 18, are as follows :—

$$\begin{aligned} O &= P \\ Q &= 2P-0 \cdot 00420 \text{ gr.} \\ R &= 4P+0 \cdot 00779 \\ S &= 8P+0 \cdot 00113 \\ T &= 16P-0 \cdot 01782 \\ V &= 64P-0 \cdot 03366 \\ U &= 32P-0 \cdot 03568 \\ W &= 128P-0 \cdot 10855 \\ \text{Whence } P+S+T+U &= 57P-0 \cdot 05237 \\ \text{And } 57P &= 5700 \cdot 03768 \text{ gr.} \end{aligned}$$

Hence the standard weight in air of these standard bronze weights, together with the difference in weight since their original verification in 1855, is as follows :—

Nominal Weight.	As now ascertained.	Determined by Professor Miller in 1855 (p. 940).	Difference since 1855.
Grains.	Grains.	Grains.	Grains.
(100)	O= 100·00066	100·00012	+0·00054
(100)	P= 100·00066	100·00000	+0·00066
(200)	Q= 199·99712	199·99640	+0·00072
(400)	R= 400·01043	400·00740	+0·00293
(800)	S= 800·00641	800·00310	+0·00331
(1,600)	T= 1599·99276	1599·99150	+0·00126
(3,200)	U= 3199·98547	3199·97780	+0·00867
(6,400)	V= 6400·00864	6399·97330	+0·03534
(12,800)	W=12799·97606	12799·89810	+0·07796

These bronze weights are slightly oxidized, causing some increase in their weight. As they have never been used since their original verification, there is no corresponding diminution of weight from wear and tear.

VERIFICATION OF GILT GUN-METAL WEIGHTS OF 4,000, 2,000, AND 1,000 GRAINS.

erification f gilt gun-metal weights of 4,000, 2,000, and 1,000 grains.

These three auxiliary standard weights are of the same form as the bullion standards, being cylindrical with the height of the cylinder exceeding its diameter by about one-fourth, and having a large knob. They have been verified by comparison with the gilt gun-metal pound, No. 34=6999·99536 grains. This gilt gun-metal 1000 grain weight is called 1000B, to distinguish it from the gilt gun-metal 1000 grain weight belonging to the set of decimal grain standards. The decimal official grain weight, 1000 No. 1, has also been used in the comparisons. This weight belongs to the set of decimal grain weights furnished by Messrs. Ladd and Oertling in 1855 (See App. II., p. 8), the weights from 1000 gr. to 10 gr. being made of gun metal not gilt, and cylindrical with the diameter of the cylinder exceeding its height about two-thirds, and having a very small knob. The balance used was Oertling's No. 3.

No.	Date of Comparison.	Number of Weighings.	Results of Weighings.	Value of One Division of Index.
	1868.			Grains.
(1)	Nov. 6 - -	15	$4000+2000+1000B \bumpeq 1$ lb. No. 34 $+0 \cdot 02018$	0·00155
(2)	„ 29 - -	15	$4000+2000+1000$ No. 1 $\bumpeq 1$ lb. No. 34 $+0 \cdot 02333$	0·00156
(3)	Dec. 1 - -	15	$2000+1000B+1000$ No. 1 $\bumpeq 4000+0 \cdot 00137$	0·00137
(4)	„ 2 - -	15	$1000B+1000$ No. 1 $\bumpeq 2000+0 \cdot 00150$	0·00144
(5)	„ 2 - -	15	1000 No. 1 $\bumpeq 1000B+0 \cdot 00342$	0·00159
	Total - -	65		

Appendix V.—*continued.*

From (1) by substitution 1000 B =1000·00150
„ (2) „ 1000 No. 1=1000·00464
„ (4) „ 2000 =2000·00464
„ (3) „ 4000 =4000·00941

Comparison (5) has been made to check the difference between the weight of 1000 B and 1000 No. 1, as shown in (25) and (26), where 1000 No. 1=1000 B + 0·00315. There is a discrepancy of only 0·00027 gr., being less than one-fifth of a division of the index scale.

REVERIFICATION OF LARGER BULLION STANDARDS, 20 oz. to 500 oz.

Comparison of larger bullion standards, 20 oz. to 500 oz. with each other.

The following comparisons have been made of the larger bullion standards with each other. From (1) to (16) excepting (13) balance No. 2 was used; in (13) and from (17) to (22) balance No. 1.

Comparisons of larger Bullion Standards with each other.

No.	Date of Comparison.	Number of Weighings.	Results of Weighings.	Difference.	Mean Difference.	Value of One Division of Index.
	1868.		Ounces. Ounces.	Grains.	Grains.	Grains.
(1)	Nov. 5 - -	15	20 ≏ 10+5+4+1	+0·04178	+0·04473	0·02028
(2)	„ 7 - -	15		+0·04768		0·01948
(3)	Oct. 5 - -	15	30 ≏ 20+10		+0·01784	0·02020
(4)	„ 6 - -	15	40 ≏ 30+10		−0·03412	0·02027
(5)	„ 6 - -	15	40+10 ≏ 30+20	−0·07650	−0·07194	0·01787
(6)	„ 13 - -	15		−0·06769		0·02164
(7)	„ 13 - -	15	50 ≏ 30+20	−0 04893	−0·05019	0·02344
(8)	Nov. 2 - -	15		−0·05145		0·03411
(9)	Oct. 13 - -	15	50 ≏ 40+20	+0·02010	+0·01967	0·02209
(10)	Nov. 2 - -	15		+0·01924		0·03553
(11)	Oct. 17 - -	15	100 ≏ 50+30+20	−0·01566	−0·01187	0·01721
(12)	„ 22 - -	15		−0·00797		0·02367
(13)	„ 6 - -	15	100 ≏ 50+40+10	+0·04381	+0·04398	0·08089
(14)	„ 14 - -	15		+0·04414		0·02316
(15)	„ 23 - -	15	100*c* ≏ 100+0·003 oz. or 100*c* ≏ 100	−0·04254 +1·39736		0·02580
(16)	„ 31 - -	15	100*c* ≏ 100+1·29018 gr. or ≏ 100	+0·04085 +1·33103		0·02918
			Mean 100*c* ≏ 100	+1·36440		
(17)	„ 30 - -	15	200 ≏ 100+100*c*	−1·54447		0·10766
(18)	„ 21 - -	15	300 ≏ 200+100	−0·00873		0·09118
(19)	„ 21 - -	15	400 ≏ 300+100	−0·07036		0·10742
(20)	„ 30 - -	15	400+100 ≏ 300+200	−0·04884		0·10106
(21)	„ 21 - -	15	500 ≏ 300+200	−0·49485		0·13154
(22)	„ 21 - -	15	500 ≏ 400+100	−0·45754		0·11248

In comparison No. 15, the 0·003 oz. bullion standard=1·43990 gr. was used, and in No. 16, two of the platinum auxiliary weights, marked Q, of 0·64509 grains each.

Results of these comparisons.

The following results, showing the actual weight of the several bullion standards, are obtained from the preceding equations :—

Bullion Standards. Gr.

(*a*) From (1) (2) 20 oz.= 9599·99855
(*b*) (3) 30 oz.= 14399·99791
(*c*) (4) 40 oz.= 19199·94531
(*d*) { (7) (8) 50 oz.= 23999·94627
{ (9) (10) 5 oz.= 23999·94650

Mean 50 oz.= 23999·94638

(*e*) { (11) (12) 100 oz.= 47999·93097
{ (13) (14) 100 oz.= 47999·91719

Mean 100 oz.= 47999·92408

(15) (16) 100*c* oz.= 48001·28848
(*f*) (17) 200 oz.= 95999·66809
(*g*) (18) 300 oz.=143999·58344
(*h*) (19) 400 oz.=191999·43716
(21) 500 oz.=239998·75668
(22) 500 oz.=239998·90370

(*k*) Mean 500 oz.=239998·83019

These results have been checked as follows :—

gr.
40+10=30+20−0·06963
From (5) (6) 40+10=30+20−0·05019

Difference 0·01944 { or less than 1 div. of index.

Again—
400+100=300+200+0·10971
From (20) 400+100=300+200−0·04884

Difference 0·15855 { or little more than 1 div. of index.

Appendix V.—*continued.*

Check by comparisons with other standard weights.

They have been further checked by the following comparisons in 1867 and 1868, of the bullion standards with the gilt gun-metal pounds and with the avoirdupois standards:—

No.	Date of Comparison.	Number of Weighings.	Results of Weighings.			Balance.	Value of 1 Division of Index.
	1868.			Grains.	Grains.		Grains.
(23)	Dec. 4	5	30 oz. bullion ≏ 1 lb. No. 32 + No. 33 + R (400 gr.)	−0·01038 or	= 14400·00234	No. 2	0·03604
(24)	„ 4	5	40 „ ≏ 1 lb. No. 32 + No. 33 + 4000 gr. + 1000 No. 1 + Q (200 gr.)	−0·03934	= 19199·97098	„	0·03312
(25)	„ 4	15	50 „ ≏ 1 lb. No. 32 + No. 33 + No. 34 + 2000 gr. + 1000 gr. No. 1	−0·02310	= 23999·98069	„	0·03659
(26)	„ 10	15	100 + 1000 gr. No. or 100 ≏ 7 lb. avoirdupois	+0·48720	= 47999·85098	No. 1	0·10454
(27)	„ 10	15	200 + 2000 gr. or 200 ≏ 14 lb. „	+0·67051	= 95999·61175	„	0·12317
(28)	„ 8	15	500 1 ≏ 28 lb. avoirdupois + 4 lb. + 1 lb. No. 32 & 34 + 2000 gr. + 0·001 oz.	−0·12179	= 239997·24831	„	0·12179
	1867.						
(29)	Sept. 3	30	(A) consisting of—	−0·04113		„	0·16585
(30)	„ 4	30	40 + 3 + 0·5	−0·06403		„	0·19704
(31)	„ 11	30	+ 0·2 + 0·05 ≏ 1 lb. No. 32 + No. 33 + No. 34	−0·07494		„	0·16654
			Mean	−0·06003	= 20999·93762		
(32)	„ 3	30	(B) consisting of—	−0·14747		„	0·17010
(33)	„ 4	30	50 + 5 + 2 + 1	−0·11900		„	0·13678
(34)	„ 11	30	+ 0·3 + 0·03 + 0·003 ≏ A + 1 lb. No. 32	−0·12795		„	0·15077
	Total -	270	Mean	−0·13147	= 27999·80962		

The differences between the results of the several weighings (23) to (34) and those marked (*a*) to (*k*) are as follows:—

(*b*) (23)	Weight of	30 oz.	Difference of	(23)+0·00443 gr.,	or about	$\frac{1}{7}$	div. of index	of Balance No. 2.
(*c*) (24)	„	40 oz.	„	(24)+0·02567 gr.	„	$\frac{3}{4}$	„	„
(*d*) (25)	„	50 oz.	„	(25)+0·03431 gr.	„	1	„	„
(*e*) (26)	„	100 oz.	„	(26)−0·07310 gr.	„	$\frac{2}{3}$	„	of Balance No. 1.
(*f*) (27)	„	200 oz.	„	(27)−0·05634 gr.	„	$\frac{1}{2}$	„	„
(*k*) (28)	„	500 oz.	„	(28)−0·58188 gr.	nearly	5	„	„

The official standard avoirdupois weights of 7, 14, and 28 lbs. used in comparisons (26) (27) (28) have been in continual use for 18 months since their reverification, and a diminution of their weight must consequently be looked for; it will be seen that the greatest difference (that in the two results of the weight of the 500 oz. bullion standard), is little more than $\frac{1}{480000}$th part of its weight.

It need hardly be added that the greatest loss of weight must be expected in the heaviest standard weights, which are frequently used for departmental purposes, as it is impossible to manipulate them without risk of loss by friction.

As regards the comparisons with the gilt gun-metal pounds, the differences are of more importance.

It has been pointed out to me by Professor Miller that in his original verification of the bullion standards, whilst the value of those bullion weights up to 30 oz. was based upon the relation of a certain number of them to the platinum troy pound T, that of the larger bullion weights was based upon a combination of the gun-metal pounds, which had been compared directly with the Imperial standard pound PS. That the errors of these last-mentioned comparisons were probably some in defect and some in excess, so that when many were taken together, they partially destroyed one another. For this reason, and also because PS is the standard and larger than T, this mode of determining the value of the larger bullion weights is less liable to error than by deriving all the larger bullion weights from the 10 oz. and smaller weights, as compared with T. It is obvious that any error in the 10 oz. and smaller weights may become largely multiplied always in the same direction in passing up to the weight of 500 oz., whilst it is not probable that so large an error would arise in deriving the weight of the larger bullion standards from several gun-metal pounds compared directly with PS.

All the gun-metal pounds which had been constructed and verified with PS, were at Professor Miller's disposal for the original verification of the bullion standards. For their reverification, four only of the 30 gun-metal pounds which were used by Professor Miller, are deposited in the Standards Department, and are available. In determining the standard weight of the bullion standards of 30, 40, and 50 ounces, I have acted on Professor Miller's suggestions, as stated above, and have assigned a double value to the comparisons of these standards with the gilt gun-metal pounds (23) (24) (25) and only a single value to their comparisons with the other bullion weights (*b*) (*c*) (*d*). The value of the 20 oz. has also been corrected by assigning an equal value to its weight as derived from the corrected value of the 30 oz. in comparison (3); and the value of the larger bullion standards has been corrected according to the corrected value of the 20, 30, 40, and 50 oz. weights.

Standard weight bullion standards.

The following table shows, therefore, the standard weight in air of all the bullion standards, as now ascertained, and as compared with their standard weight as determined by Professor Miller in 1855:—

Troy Bullion Ounces.	Standard Weight now ascertained.			As determined by Professor Miller in 1855.	Difference or Alteration of Weight.
	Grains.		Grains.	Grains.	Grains.
500	239998·99839	or	−1·00161	−0·054	−0·94761
400	191999·57168	„	−0·42832	0·000	−0·42832
300	143999·68433	„	−0·31567	+0·027	−0·34267
200	95999·73535	„	−0·26465	−0·022	−0·24265
100	47999·95771	„	−0·04229	+0·0193	−0·06159
50	23999·96925	„	−0·03075	+0·0054	−0·03615
40	19199·96242	„	−0·03758	−0·0298	−0·00778
30	14400·00086	„	+0·00086	+0·00138	−0·00052
20	9600·00002	„	+0·00002	−0·00286	+0·00288
10	4799·98152	„	−0·01848	+0·00042	−0·01890
5	2399·98571	„	−0·01429	+0·00003	−0·01432
4	1919·98813	„	−0·01187	−0·00016	−0·01171
3	1439·99425	„	−0·00575	+0·00047	−0·00622
2	959·99618	„	−0·00382	−0·00053	−0·00329
1	479·99927	„	−0·00073	+0·00032	−0·00105
1 oz.	479·99846	„	−0·00154	+0·00015	−0·00169
0·5	239·99254	„	−0·00746	+0·00013	−0·00759
0·4	191·99293	„	−0·00707	+0·00013	−0·00720
0·3	143·99655	„	−0·00345	+0·00037	−0·00382
0·2	95·99960	„	−0·00040	+0·00018	−0·00058
0·1	47·99776	„	−0·00224	−0·00038	−0·00186
0·05	23·99490	„	−0·00510	−0·00008	−0·00502
0·04	19·19515	„	−0·00485	+0·00015	−0·00500
0·03	14·39701	„	−0·00299	0·00000	−0·00299
0·025	11·99846	„	−0·00154	−0·00007	−0·00147
0·02	9·59954	„	−0·00046	−0·00066	+0·00020
0·01	4·79764	„	−0·00236	+0·00012	−0·00248
0·005	2·39981	„	−0·00019	−0·00076	+0·00057
0·004	1·91973	„	−0·00027	−0·00019	−0·00008
0·003	1·43990	„	−0·00010	+0·00036	−0·00046
0·002	0·96003	„	+0·00003	+0·00018	−0·00015
0·001	0·48033	„	+0·00033	+0·00012	+0·00021

Appendix V.—*continued.*

The two combinations of standard bullion weights denoted as (A) and (B) have also been used for the reverification of 10 lb. weight, the standard weight of a gallon of water, as will be presently shown. The difference of the weight of the several bullion standards composing (A) and (B), as now determined, compared with the weight of (A) and (B) as derived from the several direct comparisons with the gilt gun-metal pounds, (29) to (34), is as follows :—

—	Standard Weight now determined.	Derived from Comparisons (29) to (34).	Difference of determined Weight.
(A) =	20,999·94371 gr.	20,999·93762 gr.	+0·00609 gr.
(B) =	27,999·78387	27,999·80962	−0·02575

This difference is in each case less than the difference of the results of the several three weighings (29) (30) (31) and (32) (33) (34), the mean of which has been taken to show the weight of (A) and (B) from those comparisons.

Reverification of Standard 10 lb. Weights, Standard of Gallon Measure.

The gilt gun-metal standard 10 lb. weight was made by Mr. Oertling in 1854, its weight being based on that of ten of the gilt gun-metal pounds, which had been verified with the Imperial standard by Professor Miller, who lent them to Mr. Oertling for the more accurate adjustment of the new 10 lb. weight.

When originally verified in June 1854 by Professor Miller (see his Paper, p. 934), this standard 10 lb. weight, which will be designated as M, was compared with three different combinations of the 30 secondary standard pounds of gilt gun metal; the results of the weighings in standard air being as follows :—

1 div. of scale of balance=0·1355 gr.

gr.
M=10 lbs.+0·1080, by comparison with 10 of the gilt gun-metal pounds.
=10 lbs.+0·1262 „ 10 others.
=10 lbs.+0·0986 „ 10 others.

Mean +0·111

Hence it was determined to be 0·111 gr. heavier than the true standard weight of 10 lbs., or 70,000 grains.

The verification of M has now been based on the three gilt gun-metal pounds, Nos. 32, 33, and 34, and it has been compared with these three auxiliary standard pounds, and a combination of bullion standard weights, all being of gilt gun metal, viz. :—

gr.
Gilt gun-metal pounds, Nos. 32, 33, 34, together - - - - - - =20999·99765
(A), composed of bullion standards 40, 3, 0·5, 0·2, 0·05 oz. - - - - =20999·93762
(B), composed of bullion standards 50, 5, 2, 1, 0·3, 0·03, 0·003 - - =27999·80962

Making a combination of gilt gun-metal standard weights (GG) - =69999·74489

The weight of (A) and (B) is here taken as shown by comparison with the three standard pounds (see p. 50).

Kater's account, p. 27.

The 10 lb. weight M has also been compared with the 10 lb. weight of brass constructed in 1824, and verified by Capt. Kater, as the base of the verification of the legal standard gallon, the unit of the measures of capacity. Capt. Kater verified his weight, which will be designated as K, by comparing it with two 6 lb. troy weights, of which the weight had been accurately determined, and 880 grains, making together 10 lbs. avoirdupois. All these brass weights were constructed with a button screwed into the top, beneath which a small cavity was left to receive such minute pieces of wire as might be found requisite to make up the standard weight. After some rough trials, Capt. Kater added a piece of wire=0·16 grain to the 10 lb. weight, and the result of the final comparisons were as follows :—

gr.
Mean error of 6 weighings −0·272
„ 8 „ −0·155
„ 6 „ −0·192

Mean −0·206

He accordingly added a second piece of wire equal to the mean error. The weight K, therefore, now contains two wires weighing together 0·366 gr.

COMPARISONS OF M AND K.

No.	Date of Comparison.	Number of Weighings.	Results of Weighings.		Value of 1 Division of Index.
	1867.			Grains.	
(1)	Aug. 31	30	M + balance weight 0·199 gr. ≏ + balance weight 1·99988 gr.	+0·06237	0·16500
(2)	Sept. 4	30	M ≏ GG + balance weights 1·99988 and 0·199 gr. -	+0·20105	0·16445
(3)	„ 5	30		+0·22192	0·17849
		90	Mean of (2) (3)	+0·21148	

Hence M=70002·15525 gr., or 2·15525 gr. in excess of standard weight; and K=M−1·86325 gr.=70000·292, or 0·292 in excess.

That Capt. Kater's brass weight, which has never been used since it was deposited at the Exchequer in 1824, should have gained a little by oxidation might have been expected; but the apparent increase of weight in the 10 lb. standard of gilt gun metal since 1854 is difficult to explain.

It will be observed that the weighings of M with the gilt gun-metal bullion standards have been made in air, without making any allowance for the weight of air displaced. Such allowance was made by Professor Miller in his comparisons of 1854. It appears from the notes which he has placed in my hands that the excess of standard air displaced by the respective combinations of gilt gun-metal pounds in each of the three several comparisons was as follows :—

+0·21810 gr.
+0·19095 „
+0·13559 „

Mean +0·18151 „

In this case the average density of the gun-metal pounds was less than that of M. The density of the gun-metal bullion standards is greater than that of M, the excess of standard air displaced by the latter being 0·13390 gr. But if this excess were taken into account at all, it would only serve to make the apparent increase of M so much more.

Not only does Professor Miller's well known accuracy, as well as the near accordance of the results of his several comparisons, forbid the supposition of any error in his determination of M in 1854, but the fact of his having then compared this standard with K leads also to the inference that M must have since increased in weight. He found it to be about 0·366 gr. heavier than K, which would make the latter to have been 0·255 gr. light. As it is now found to be 0·292 gr. heavy, it would appear to have gained 0·547 gr., and notwithstanding, it is shown to be 1·86325 gr. lighter than M. If the facts really are so, M must have gained 2·04425 grains.

Verification of Pyx Troy Weights.

Descri of Pyx weigh

These weights, nine in number, from 1 lb. to 30 lbs., were constructed and supplied to the Department in 1845, under the authority of the Treasury letter of 2nd August 1842 (see Coinage Report, No. 293 of 1866, App. IX.), for the purpose of being used at trials of the pyx, but they have never been used either for that or any other purpose. Nor up to the present time have they ever been verified by comparison with the official standards.

They are made of brass, and the larger weights are more or less oxidized, the 30 lb. being the most oxidized. Each is marked on one side with its weight in pounds troy, and on the other side in troy ounces.

Comp of Pyx weigh

The verification of the Pyx weights has been based on the 10 oz. and 2 oz. bullion standards, the standard weight of both being 5759·97770 grains, or 0·02230 grain less than Imperial standard. The actual comparisons are as follows ;—

Appendix V.—*continued.*

No.	Date of Comparison.	Number of weighings.	Balance used.	Value of 1 Division of Index.	Results of Weighings.		Consequent Standard Weight of Pyx Weights.	Excess (+) or Deficiency (−).
	1868.			Gr.	Pyx Weights.	Grains.	Grains.	Grains.
1	Nov. 28	15	No. 3	0·00133	1 lb. troy, or 12 oz. ≏ 10 oz. + 2 oz.	+0·03372	5760·01142	+0·01142
2	„ 30	15	No. 2	0·00249	2 „ or 24 oz. ≏ 1 lb. + 10 oz. + 2 oz.	+0·15692	11520·14604	+0·14604
3	„ 5	15	„	0·03395	3 „ or 36 oz. ≏ 1 lb. + 2 lb.	−0·09168	17280·06578	+0·06578
4	„ 5	15	„	0·03317	4 „ or 48 oz. ≏ 1 lb. + 3 lb.	−0·12570	23039·95150	−0·04850
5	„ 5	15	„	0·03635	5 „ or 60 oz. ≏ 1 lb. + 4 lb.	+0·05555	28800·01847	+0·01847
6	„ 4	15	No. 1	0·13118	10 „ or 120 oz. ≏ 1 lb. + 4 lb. + 5 lb.	−0·09071	57599·89068	−0·10932
7	„ 4	15	„	0·08533	15 „ or 180 oz. ≏ 5 lb. + 10 lb.	−0·45048	86399·45867	−0·54133
8	„ 4	15	„	0·10810	20 „ or 240 oz. ≏ 5 lb. + 15 lb.	+0·39366	115199·87080	+0·12920
9	„ 3	15	„	0·08741	30 „ or 360 oz. ≏ 10 lb. + 20 lb.	−11·67	172788·09162	−11·90838

These results have been checked by the following comparisons with bullion standards, which may also serve as a test of the ascertained weight of these standards as already stated:—

No.	Date of Comparison.	Number of weighings.	Balance used.	Value of 1 Division of Index.	Results of Weighings.			Standard Weight of Pyx Weights.	Excess (+) or Deficiency (−) as compared with previous comparison.
					Pyx Weights.	Bullion Standards.			
	1868.			Grains.		oz.	Grains.	Grains.	Grains.
10	Nov. 19	15	No. 2	0·03328	2 lbs. troy, or 24 oz.	≏ 20 + 4	+0·15644	11520·14459	−0·00145
11	„ 19	15	„	0·03551	3 „ or 36 oz.	≏ 30 + 4 + 2	+0·11237	17280·09754	+0·03176
12	„ 18	15	„	0·03397	4 „ or 48 oz.	≏ 40 + 5 + 3	+0·06072	23040·00310	+0·05160
13	„ 18	15	„	0·03115	5 „ or 60 oz.	≏ 50 + 10	+0·11493	28800·06570	+0·04723
14	„ 18	15	No. 1	0·08649	10 „ or 120 oz.	≏ 100 + 20	+0·07171	57600·02944	+0·13876
15	„ 18	15	„	0·09293	15 „ or 180 oz.	≏ 100 + 50 + 30	−0·48362	86399·44430	−0·01447
16	„ 17	15	„	0·09005	20 „ or 240 oz.	≏ 200 + 40	+0·26208	115199·95985	+0·08905
17	„ 17	15	„	0·10170	30 „ or 360 oz.	≏ 300 + 50 + 10	−11·63109	172788·00401	−0·08761

The differences in the two results are so small, more particularly when it is considered that no allowance has been made in the last comparisons for the difference of density of the brass and gilt gun-metal weights, as to confirm the accuracy of the preceding comparisons of the pyx weights with each other. Their standard weight may therefore be considered to be now determined, as shown in comparisons No. 1 to 9.

Reverification of Standard Weight 62·321 lbs., used for determining the legal Unit of Gas Measure.

Reverification of standard 62·321 lbs. weight.

Under s. 2 of the Sale of Gas Act, 1859, the legal standard or unit of measure for the sale of gas by meter is declared to be the cubic foot, containing 62·321 pounds avoirdupois weight of distilled or rain water weighed in air, at the temperature of 62° Fahr., the barometer being at 30 inches.

Commons paper, No. 100, of 1860, p. 2.

The standard weight used for determining the standard cubic foot measure, and made of hard gun-metal, was constructed by Mr. Oertling. It was delivered at the Exchequer on 12th November 1859, and was verified on November 14 and 15, under the personal superintendence of the Astronomer Royal and Professor Miller. First, by means of a selection of standard weights in the Exchequer, with the addition of some very minute auxiliary weights, an aggregate of 62·321 lbs. was formed, and then by means of the large official balance, Mr. Oertling's weight was examined, adjusted, and verified, and was left without sensible error. During the verification Mr. Hamilton of the Treasury, Sir Edward Ryan, Assistant Comptroller, Mr. Oertling, Mr. Ladd, Mr. Crosley, and Mr. Bowen were present. There is no record in the Department of any further details of the verification of this standard weight, called 62·321 lbs. No. 1, nor of the actual standard weights used for verifying it. It is, however, satisfactory to have learned from Professor Miller, *since* its more recent comparison with a combination of the official standard bullion weights, as presently described, that the same identical standard weights (except only the 0·1 oz. and 0·004 oz.) were used for its original verification as have now been used for its reverification.

Besides being used for verifying the cubic foot standard measure, this standard weight was also employed to verify three copies, intended for the three metropolitan cities of London, Edinburgh, Dublin, but which were not sent to those places, and they still remain in the Standards Department. They are recorded as having been verified at the Exchequer by the Astronomer Royal on 13th February 1860, in the presence of the same persons as before mentioned, including also Lord Monteagle, but Professor Miller is not stated to have been present. The official record of their verification is as follows:—

62·321 lbs. weight No. 2.—2 grains placed in the cavity made it correct.

„ „ No. 3.—Found a little heavy; being reduced, 1 grain placed in the cavity made it correct.

„ „ No. 4.—4 grains placed in the cavity made it correct.

Its comparison with bullion and avoirdupois standards.

The standard 62·321 lbs. weight has now been compared with the following respective combination of gilt gun-metal bullion standards (B), and of brass avoirdupois standards (A); Oertling's large balance No. 1 being used:—

(B.) Bullion Standards.	Actual Standard Weight determined in 1868.	(A) Avoirdupois Standards.	Actual Standard Weight determined in 1866.
oz.	Grains.	lbs. oz. dr.	Grains.
500	=239,998·99839	56 0 0	391,988·14352
400	=191,999·57168	4 0 0	27,999·42166
5	= 2,399·98571	2 0 0	13,999·59566
3	= 1,439·99425	0 4 0	1,749·76122
0·5 0·3	= 239·99254 = 143·99655	0 1 0	437·35847
0·1	= 47·99776	0 0 4	109·27099
0·05 0·004	= 23·99490 = 1·91973	0 0 0½	13·65612
908·954	=436,296·45151	62 5 4½	=436,297·20764

Whence it would appear that (B)=(A)−0·75613 gr.

Appendix V.—*continued.*

COMPARISONS of STANDARD 62·321 lbs. Weight, (or 436,247 gr.)

No.	Date of Comparison.	Number of Weighings.	Results of Weighings.	Value of One Division of Index.
			Grains.	Grains.
(1)	1868, Dec. 19	15	Standard 62·321 lbs. ♎ (B) +1·43583	0·15782
(2)	„ „ 21	12	„ „ ♎ (B) +1·43532	0·21503
			Mean - +1·43557	
(3)	„ „ 23	15	„ „ ♎ (A) +1·55312	0·17301
(4)	„ „ 23	15	„ (B) ♎ (A) +0·02333	0·19304
		57		

Whence from mean of (1), (2), standard 62·321 lb. = 436,297·88708 gr., or - } 50·88708 gr. too heavy.
From mean of (3), standard 62·321 lb. = 436,298·76076 gr., or - - - - } 51·76076 „

Difference of these two results - } (3) +0·87368 „

Considering that the avoirdupois standards have been more than 18 months in continual use since the determination of their standard weight in 1866, and that the density of the gilt gun-metal weights is greater than that of the brass weights, the difference in the two results is not more than might be expected. Preference must be given to the comparison with the bullion standards, and accordingly the actual standard weight of the standard 62·321 lbs. = 436,297·88708 gr., or 50·88708 gr. too heavy.

Comparison (4) has been taken to check the accuracy of the preceding comparisons.

From the mean of (1), (2), and from (3), (B) ♎ (A) +0·11755 gr.
And by direct comparison (4), (B) ♎ (A) +0·02333 „

Difference - - - 0·09422 „ being about ½ div. of index.
Mean of the two equations (B) ♎ (A) +0·07038 „

Difference of weight as determined by their actual standard weight in 1866 and 1868 - - - - } (B) ♎ (A) +0·75613 „

Whence presumed loss of weight since 1866 of (A) - 0·82651 „

which corresponds very nearly (within 0·04717 gr.) with the difference of the two results (1), (2), and (3), as previously shown.

These tests appear not only sufficient to prove the accuracy of the actual weight of the 62·321 lbs. standard, as now determined, *but also the truth of the determination of the standard weight of the larger avoirdupois and bullion standards.*

Apparent increase in weight since 1859.

With reference to this apparent increase in the weight of the 62·321 lbs. standard, it should be observed that there has been only one instance of the comparison with the standard and official verification of a local standard weight of 62·321 lbs., one having been verified for the borough of Sheffield in 1861.

It appears from the correspondence book of the Department that the Sheffield weight was first tested on 10th May 1861, and was rejected as being 25 grains light. On 13th May, Mr. Crosley, who was the agent employed, represented to the Comptroller General that the Sheffield weight had been constructed by Messrs. De Grave, who had tested it with their copies of the Exchequer standards, and were convinced that the weight, so far from being light, was two or three grains heavy; that Mr. Crosley had himself tested it with Messrs. De Grave's copies of the standard weights with a similar result; that he was present when the Exchequer standard weight was compared and verified by the Astronomer Royal and Professor Miller, on 15th Nov. 1859, when he took note of the weights employed, and that when it was passed it was only 0·999 grains heavy; and that he could come to no other conclusion, that by some means or other the Exchequer standard was not of the same weight as when it was tested, and that it had become incorrect.

On 14th May the Comptroller General replied that the Exchequer standard weight of 62·321 lbs. was legally established as a standard, and he would not feel at liberty to verify and stamp any weight represented to be a copy of such standard, unless it corresponded with it in gravity.

On 15th May Mr. Crosley stated he had no alternative but to comply with the Comptroller General's decision, but repeated that the Exchequer standard appeared to have altered in weight since 1859.

On 16th May the Comptroller General, in reply, enclosed a report from Mr. Bowen, stating that the Exchequer standard had been kept carefully under lock and key since its original verification, and had not been used till the 10th instant; that it was then used for the comparison of the Sheffield weight, which was found about 25 grains light; and that another comparison, with a similar result, was made on the 16th May, in the presence of Messrs. De Grave and Crosley. The Comptroller General added that he could not assume that the standard weight had varied and become heavier since its deposit at the Exchequer; that he was not authorized by law to set aside or depart from the standards so deposited, and on these grounds the Sheffield weight had been rightly rejected.

It further appears, by a letter from Mr. Crosley of 21st May, that although he retained his opinion that the Exchequer standard was too heavy, in order to obtain the Exchequer verification and stamp, he increased the weight of the Sheffield copy to that of the Exchequer standard, and it was verified accordingly.

Compa
with its
three b
copies.

As a further means of judging whether the standard 62·321 lbs. weight has increased in weight, it has again been compared with the three brass copies, Nos. 2, 3, and 4, already stated to have been adjusted in 1860, so as to correspond in weight with the standard.

COMPARISON of the STANDARD 62·321 lbs. Weight with the three Copies Nos. 2, 3, and 4.

Date of Comparison.	Number of Weighings.	Result of Weighings.	Value of 1 Div. of Index of Balance No. 1.
1868, Dec. 29	15	Standard 62·321 lbs. ♎ brass copy No. 2 −3·17420 gr.	0·24851 gr.
	15	„ ♎ „ No. 3 + 0·03 oz. +2·04773 „	0·25464 „
	15	„ ♎ „ No. 4 + 0·05 oz. + 0·02 oz. +2·95149 „	0·17940 „

Whence standard 62·321 lbs. = brass copy No. 2 − 3·17420 gr.
„ = „ No. 3 + 16·44474 „
„ = „ No. 4 + 36·54593 „

Appendix V.—*continued.*

Unsatisfactory results.

These results, so far from solving the difficulty, only serve to render it more inexplicable. It is desirable that the early attention of the Commission should be directed to the subject, with a view of making the 62·321 lbs. weight of its true standard weight. This question will have to be determined before the reverification of the gas-measuring standards are proceeded with, which must be based upon the standard 62·321 lbs. weight.

Verification of Official Decimal Grain Weights.

Verification of decimal grain weights.

A series of decimal grain weights from 1000 grains to 0·01 grain, has already been mentioned in Appendix III., p. 16, as having been constructed by Mr. Oertling, and deposited at the Exchequer in 1855; that upon recent trial they were found not to be very exact, they were consequently readjusted by Mr. Oertling in October 1866. In Note (A), p. 19, it is stated that a comparison of these weights was subsequently made, and that they were then found sufficiently exact as balance weights.

The weights from 1000 to 10 grains, inclusive, are made of gun-metal of the form stated at p. 48; from 6 to 1 grain, they are of platinum; and from 0·06 to 0·01 grain, of aluminium.

It will be observed that this decimal series comprehends the units 6, 3, 2, 1, below 10, whilst that of the bullion weights consists of the units of 5, 4, 3, 2, 1. The decimal grain weights were so constructed by Mr. Oertling, because this series is commonly used for chemical purposes; practically it is more convenient for use and requires one weight less in each series. It is certainly more convenient for deducing the actual value of each weight from comparisons with each other, than the decimal series of bullion standards, and than the French metric decimal series of 5, 2, 1, although this last series contains one denomination of weights less.

The Standards Commission having recommended in their First Report, s. 6, that the decimal series of grain weights should be legally constituted as standards, a new set has been recently constructed by Messrs. Oertling, under my directions, in order that they may be accurately verified, and constituted legal secondary standards. They will be distinguished, by being gilt, from the set made in 1855, which will be termed the "official decimal grain weights No. 1," to be used for ordinary departmental comparisons. The 1000 grain weight of this official set is called 1000 gr. No. 1, its standard weight having been already determined to be 1000·00464 grains. (See p. 52.)

The following comparisons of these official decimal grain weights have now been made; the weights of the new standard set for 100 and 10 grains were used as counterpoises, and duplicate counterpoise weights of 1 gr., 0·1 gr., and 0·01 gr. were used.

ACTUAL COMPARISON of Official Decimal Grain Weights.

No.	Date of Comparison.	Results of Weighings.			Balance used.	Value of a Division.
	1868.			gr.		gr.
1	Oct. 10	1000 No. 1	≏600 + 300 + 100 − 0·00269	} gr −0·00261	No. 3.	0·00162
2	„ 27	1000 No. 1	≏600 + 300 + 100 − 0·00254		Barrow.	0·00153
3	Dec. 18	600	≏300 + 200 + 100 -	−0·00166	No. 3.	0·00165
4	„ „	300	≏200 + 100 - - -	−0·00049	No. 4.	0·00079
5	„ „	200	≏100 + 100*c* - - -	+0·00164	„	0·00082
6	„ 22	100	≏100*c* - - -	+0·00148	„	0·00085
7	„ 18	100	≏60 + 30 + 10 - -	−0·00189	„	0·00088
8	„ „	60	≏30 + 20 + 10 - -	−0·00054	„	0·00098
9	„ 19	30	≏20 + 10 - - -	+0·00013	„	0·00089
10	„ „	20	≏10 + 10*c* - - -	−0·00015	„	0·00091
11	„ „	10	≏10*c* - - -	+0·00129	„	0·00090
12	„ „	10	≏6 + 3 + 1 - - -	+0·00059	„	0·00090
13	„ „	6	≏3 + 2 + 1 - - -	−0·00052	„	0·00090
14	„ „	3	≏2 + 1 - - -	+0·00035	„	0·00091
15	„ „	2	≏1 + 1*c* - - -	−0·00032	„	0·00090
16	„ 21	1	≏1*c* - - - -	−0·00022	„	0·00092
17	„ „	1	≏0·6 + 0·3 + 0·1 - -	+0·00049	„	0·00090
18	„ „	0·6	≏0·3 + 0·2 + 0·1 - -	+0·00036	„	0·00090
19	„ „	0·3	≏0·2 + 0·1 - - -	+0·00003	„	0·00090
20	„ „	0·2	≏0·1 + 0·1*c* - - -	−0·00015	„	0·00089
21	„ „	0·1	≏0·1*c* - - -	±0·00000	„	0·00090
22	„ 22	0·1	≏0·06 + 0·03 + 0·01 -	−0·00036	„	0·00091
23	„ „	0·06	≏0·03 + 0·02 + 0·01 -	+0·00027	„	0·00088
24	„ „	0·03	≏0·02 + 0·01 - -	+0·00024	„	0·00090
25	„ „	0·02	≏0·01 + 0·01*c* - -	−0·00052	„	0·00089
26	„ „	0·01	≏0·01*c* - - -	+0·00012	„	0·00091
27	„ „	1000 No. 1	≏600 + 200 + 100 + 60 + 20 + 10 + 6 + 3 + 1 - -	−0·00506	„	0·00084
28	„ „	1	≏0·6 + 0·2 + 0·1 + 0·06 + 0·03 + 0·01 - -	+0·00015	„	0·00090
29	„ „	1	≏1 gr., 1824 - -	+0·00030	„	0·00089
30	„ 11	R (400 gr.)	≏300 + 100 - - -	+0·00803	No. 3.	0·00169
31	„ „	Q (200 gr.)	≏200 - - -	−0·00398	„	0·00170

Appendix V.—*continued.*

The standard weight of each of these decimal grain weights has been determined from these equations by the following process of substitution, applicable to each decimal series;—

1000 No. 1 grain weight = 1000·00464 gr.
(1) (2) 600 + 300 + 100 ≏ 1000 No. 1 + 0·00261

or 1000·00725
(3) 300 + 200 + 100 ≏ 600 - - + 0·00166

∴ 2(300) + 200 + 2(100) = - 1000·00891 and (6) 100 ≏ 100c + 0·00148 gr.
(5) 100 + 100c ≏ 200 − 0·00154

As 2(100) = 200 - − 0·00016 ∴ 2(100) = 200 − 0·00016
(4) 200 + 100 ≏ 300 + 0·00049

And 6(100) = 2(300) - + 0·00066 ∴ 3(100) = 300 + 0·00033

Therefore 10(100) = - - 1000·00941
∴ 100 = - - - 100·00094
200 = {200·00188 + 0·00016} 200·00204
300 + {300·00292 − 0·00033} 300·00249
600 = {600·00548 − 0·00166} 600·00382
Proof, 600 + 000 + 100 = 1000·00725 gr.

Results of Comparisons.

	Official Decimal Grain Weights.	Standard Weight.	More + or less − than Standard.
	gr.	gr.	gr.
	1000 No. 1	= 1000·00464	+ 0·00464
From (1) (2) (3)	600	= 600·00382	+ 0·00382
(4)	300	= 300·00249	+ 0·00249
(5)	200	= 200·00204	+ 0·00204
(6)	100	= 100·00094	+ 0·00094
(7) (8)	60	= 60·00117	+ 0·00117
(9)	30	= 30·00092	+ 0·00092
(10)	20	= 20·00004	+ 0·00004
(11)	10	= 10·00074	+ 0·00074
(12) (13)	6	= 5·99980	− 0·00020
(14)	3	= 3·00033	+ 0·00033
(15)	2	= 1·99995	− 0·00005
(16)	1	= 1·00002	+ 0·00002
(17) (18)	0·6	= 0·59983	− 0·00017
(19)	0·3	= 0·29975	− 0·00025
(20)	0·2	= 0·19976	− 0·00024
(21)	0·1	= 0·09995	− 0·00005
(22) (23)	0·06	= 0·06012	+ 0·00012
(24)	0·03	= 0·03004	+ 0·00004
(25)	0·02	= 0·01965	− 0·00035
(26)	0·01	= 0·01015	+ 0·00015

These results have been thus checked:—

gr.
600 + 200 + 100 + 60 + 20 + 10 + 6 + 3 + 1 grain weights = 1000·00890
1000 No. 1 = 1000·00464

Whence 600, &c. = 1000 No. 1 + 0·00426
(27) By direct comparison - 600, &c. ≏ 1000 No. 1 + 0·00506

Difference of results - 0·00080 or 1 div. of Index.

0·6 + 0·2 + 0·1 + 0·06 + 0·03 + 0·01 grain weights ≏ 0·99985
1 = 1·00002

Whence 0·6, &c. = 1 − 0·00017
(28) By direct comparison - - 0·6, &c. ≏ 1 − 0·00015

Difference of results - 0·00002

1 grain weight = 1·00002
1 standard troy grain, 1824 = 0·99965

Whence 1 = 1 troy grain + 0·00037
(29) By direct comparison - - 1 ≏ 1 troy grain + 0·00030

Difference of results - 0·00007

300 + 100 grain weights = 400·00343
Bronze grain R (400) = 400·01043

Whence R = 300 + 100 + 0·00700
(30) By direct comparison - - R ≏ 300 + 100 + 0·00803

Difference of results - 0·00103 or ⅔ div. of Index scale.

200 grain weight = 200·00204
Bronze grain Q (200) = 199·99712

Whence Q = 200 - − 0·00492
(31) By direct comparison - - Q ≏ 200 - − 0·00398

Difference of results - 0·00094 or ½ div. of Index scale.

Appendix V.—*continued.*

These differences represent the total errors of all the weighings of which they are the results, and they are so small that they appear only to confirm the general accuracy of the results of the comparisons (1) to (26), which may thus be taken as determining the standard weight of each of these official decimal grain weights.

I propose to verify in the same manner the new set of decimal grain weights intended to be constituted the legal secondary standards, which are of gilt gun metal down to 10 gr. But we have found by experience that during our comparison when two similar minute weights are used, which have no distinguishing marks, it is very difficult to distinguish one from the other, and there is great risk of mistaking them, and thus assigning an incorrect value to both. To avoid this risk, I have directed Mr. Oertling to furnish a set of the smaller grain weights from 6 gr. downwards, distinguished by being gilt, and similar to those from 1000 gr. to 10 gr.

Duplicate sets of all the official standards recommended.

Indeed it is very desirable that, as a general rule, the Standards Department should be provided with a complete set of legal standards of every description of weights and measures, as standards of reference, and with a second complete set of official copies for the ordinary departmental comparisons. In the cases of both the avoirdupois standard weights and the bullion standards, not only has much difficulty been caused in the Department from having only one set of standards, but the consequent delay in comparing and verifying the local standards has given rise to numerous complaints and much public inconvenience. Such evils may in future be avoided by the construction of new avoirdupois weights as standards, and the re-adjustment of the existing avoirdupois standards and their counterpoises to serve for the official copies; and as regards the bullion standards by the re-adjustment of their counterpoises, which are now far from accurate, so that they may serve as the official copies.

If the Commission concur in these views, they may at once be carried into effect. An account of the adjustment and official reverification of the existing standard weights and counterpoises herein referred to, and of the verification of the new standard weights when constructed, showing that all are fit for the purposes of standards, will be hereafter drawn up and laid before the Commission in completion of this paper.

H. W. CHISHOLM,
Warden.

Standards Department,
2nd January 1869.

PART III.—FURTHER VERIFICATION OF OFFICIAL STANDARD IMPERIAL WEIGHTS.

CONTENTS.

Page
Verification of supplementary weights for correction of avoirdupois standard weights - - - - 59
Actual comparison of these supplementary weights - 60
Verification of decimal grain standard weights - - ,,
Their description and form - - - - - ,,
Actual comparison of standard set for reference - - 61
Verification of additional weights of 500, 50, 5, 0·5, and 0·05 gr. - - - - - - - 62
Their actual comparison - - - - - - 63
Risk of losing these minute standard weights - - ,,
New standard weights substituted for weights so lost - ,,
Corrected list of decimal grain standard weights - 64
Reverification of standard 10 lb. weight (M), and original verification of new official standard 10 lb. (O) - - ,,
Their actual comparisons - - - - - - ,,
Cause of differences in stated values of one division of balance - - - - - - - ,,
Results of comparisons of M and O, and with K - - 65
Re-adjustment and final determination of O - - ,,
Re-adjustment and reverification of standard cubic foot weights of 63·321 lbs. - - - - - ,,
Their actual comparisons - - - - - - ,,
Construction and verification of new series of fourteen standard weights of 1 lb.:
Construction of these 1 lb. standard weights - - 66
Form of new standard 1 lb. weight - - - ,,
Observations for calculation of densities - - - ,,
Formula for calculating densities - - - - - 66
Method of weighing adopted by Professor Miller - - ,,
Apparatus for weighing in water now used - - 67
Tables of Logarithms of ratios of maximum density of water - - - - - - - - - 68
Observations for determining density of standard 1 lb., No. 35 - - - - - - - ,,
Table of densities of new standard 1 lb. weights - - 69
Actual comparison of these new standard weights - ,,
Reverification of five of the new weights, after re-adjustment - - - - - - - - 70
Corrected table of the standard weight of the fourteen new 1 lb. weights - - - - - - - 71
Construction of new official standards of avoirdupois weights - - - - - - - - ,,
First comparison of 1 lb. weight, and under, and the results ,,
Re-determination of old official standards of 1 lb. and under, with their supplementary weights - - ,,
Second comparison of new avoirdupois standards under 1 lb. - - - - - - - - - 72
Comparisons of the new standard weights, 2 lb. to 56 lb., and results - - - - - - - 73
Recomparison of larger standard weights, 14, 28, and 56 lb. - - - - - - - - 74
Official Minute, 4th April 1870, stating standard weight of new official avoirdupois standards - - - ,,
Construction and verification of new standard weights of ½ and ¾ oz. for foreign postal services - - - ,,

Verification of the Supplementary Weights for correction of the official Avoirdupois standard Weights.

Verification of supplementary weights for correction of avoirdupois standards.

These supplementary weights were furnished by Mr. Oertling, under the direction of the Warden of the Standards, on 10th of October 1867, and they have been since used, in correction of the official standards of avoirdupois weights, for all comparisons of local standards required to be verified in the Standards Department. The verification of these supplementary weights has been necessarily delayed until the accurate standard weight of the series of decimal grain weights had been ascertained, so as to afford the means of verifying with precision the supplementary weights. In making the comparisons, balance No. 4 has been used, and 12 weighings have been made in each case.

Appendix V.—*continued.*

Actual Comparison of Supplementary Weights.

No. of Comparison.	Date of Comparison.	Results of Weighing.				Actual Weight of Supplementary Weights.	Difference of Actual and Nominal Weight of Supplementary Weights.
		Nominal Weight of Supplementary Weight.	Decimal Grain Weights with which compared.	Difference of Supplementary Weights.	Value of One Division of No. 4 Balance.		
	1869.	Grains.	Gr. Gr.	Gr.	Gr.	Gr.	Gr.
(1)	Mar. 16	(For 56 lbs.) 11·85648	≏10+1+0·6+0·2+0·03+0·02 (11·85004)	+0·00687	0·00095	11·85691	+0·00043
(2)	" 18	(" 28 lbs.) 1·38216	≏1+0·3+0·06+0·03 (1·38993)	−0·00798	0·00096	1·38195	−0·00021
(3)	" "	(" 14 lbs.) 1·05412	≏1+0·03+0·02 (1·04971)	+0·00439	0·00091	1·05410	−0·00002
(4)	" "	(" 7 lbs.) 0·63472	≏0·6+0·03 (0·62987)	+0·00550	0·00093	0·63537	+0·00065
(5)	" "	(" 4 lbs.) 0·57834	≏0·3+0·2+0·06+0·02 (0·57928)	+0·00008	0·00092	0·57936	+0·00102
(6)	" "	(" 2 lbs.) 0·40434	≏0·3+0·1+0·01 (0·40985)	−0·00536	0·00094	0·40449	+0·00015
(7)	" "	(" 1 lb.) 0·85009	≏0·6+0·2+0·03+0·02 (0·84928)	+0·00219	0·00092	0·85147	+0·00138
(8)	" 19	(" 8 ozs.) 0·37612	≏0·3+0·06+0·02 (0·37952)	−0·00300	0·00092	0·37652	+0·00040
(9)	" "	(" 4 ozs.) 0·23878	≏0·2+0·03+0·01 (0·23995)	−0·00108	0·00092	0·23887	+0·00009
(10)	" "	(" 2 ozs.) 0·15554	≏0·1+0·03+0·02 (0·14964)	+0·00617	0·00094	0·15581	+0·00027
(11)	" 20	(" 1 oz.) 0·14153	≏0·1+0·03+0·01 (0·14114)	+0·00151	0·00092	0·14165	+0·00012
(12)	" "	(" 8 dms.) 0·12247	≏0·1+0·2 (0·11960)	+0·00262	0·00092	0·12222	−0·00025
(13)	" "	(" 4 dms.) 0·10401	≏0·1 (0·09995)	+0·00421	0·00094	0·10416	−0·00015
(14)	" "	(" 2 dms.) 0·04777	≏0·03+0·02 (0·04969)	−0·00187	0·00091	0·04782	−0·00005
(15)	" 23	(" 1 dm.) 0·03620	≏0·03+0·01 (0·04019)	−0·00390	0·00091	0·03629	+0·00009
(16)	" 22	(" ½ dm.) 0·01575	≏0·02 (0·01965)	−0·00345	0·00091	0·01620	+0·00045
(17)	" 23	(" a duplicate balance weight of bent wire, =0·01 gr.)	≏0·01 (0·01015)	−0·00006	0·00092	0·01009	+0·00009

These results afford the means of judging of the precision with which such minute weights are constructed by Mr. Oertling, and their errors in relation to the standard determined in the Standards Department by means of the very accurate balances constructed by Messrs. Ladd and Oertling.

Verification of Decimal Grain Standard Weights.

Verification of decimal grain standard weights.

The verification of the decimal grain *standard* weights has been already mentioned at p. 55 of Appendix V. The series there described as having been compared and the standard weight ascertained is that of the *official* set of decimal grain weights, being the original set constructed in 1855. The set proposed to be legalised as the imperial standards of decimal grain weights, and to be kept as standards of reference, is there referred to as having been recently constructed by Mr. Oertling. This set is distinguished by being gilt, and its verification will now be described.

The decimal scale of both these sets of grain weights was formed of the series of units 1, 2, 3, 6, 10, and all the weights of both sets have been accurately verified and their standard weight determined. But the Commission having resolved, on 21st December 1869 (*see* Minutes, s. 5), that the most convenient scale was 1, 2, 3, 5, 10, both sets of decimal scale weights have been accordingly altered to this scale, and the complete number has now been accurately verified.

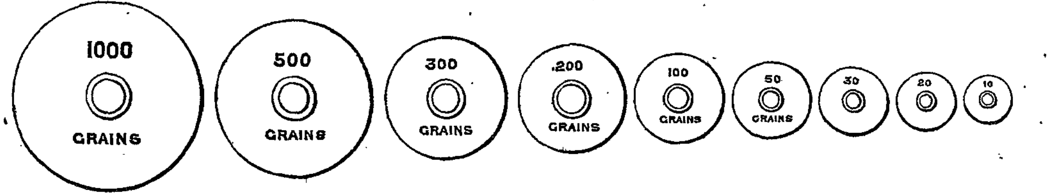
Their description and form.

Keeping in view the principle laid down by the Commission, that each series of weights should be of a distinctive form, it will be seen from the following description of the forms and dimensions of the standard decimal grain weights that they are easily distinguishable from other imperial weights; and it is suggested that all copies of these standards should be made of the same form and dimensions.

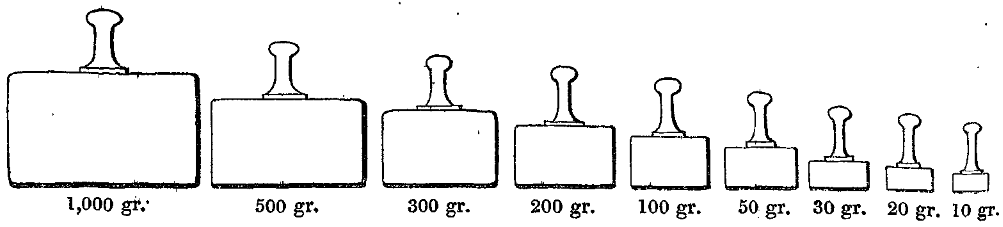
The weights from 1,000 grains to 10 grains are of Baily's metal, cylindrical in shape, with a knob, and marked with their denomination. The weights of 5 grains down to 0·01 grain are of aluminium wire, each decimal series having the wire of a different size, and bent so that the number of sides indicate their denomination.

Decimal Grain Standard Weights from 1,000 *to* 0·01 *grains.*

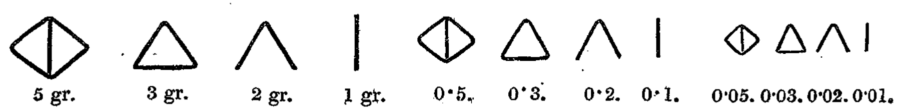
Plan of Weights, actual size.



Section of Weights, actual size.



Plan of Aluminium Wire Weights, actual size.



The size of the wire of the gilt set is much smaller than that of the ungilt.

Appendix V.—*continued.*

Dimensions of the cylindrical weights with knobs, in twelfths of an inch:—

—	1,000.	500.	300.	200.	100.	50.	30.	20.	10.
Cylinder:									
Diameter	12	9	8	6	5	4½	4	3½	3
Height	8	6	5	4	3½	3	2	1½	1
Knob:									
Height	3	3	3	3	3	3	3	3	3
Diameter:									
Upper	2	1¾	1¾	1½	1½	1¼	1¼	1¼	1
Lower	2½	2½	2½	2	1¾	1½	1½	1½	1

Each set of these decimal grain weights is conveniently fitted in a mahogany box.

Actual comparison of the standard set for reference.

In the following comparisons of the standard decimal grain weights, their verification has been based on the standard weight of the two weights of 1,000 grains, B. and No. 1. B belongs to the set of gilt gun-metal weights of 4,000, 2,000, and 1,000 grains, to which also belong the weight of 500 grains B, now verified for the first time, and No. 1 to the set of official grain weights. Their standard weight has been determined as follows (*see* Appendix V., p. 52):—

Gilt gun-metal weight, 1,000 grains B = 1000·00150 grains.
Gun-metal weight, 1,000 grains No. 1 = 1000·00464 „

Actual Comparison of Standard Decimal Grain Weights.

No.	Date of Comparison.	Result of Weighings.		Balance used.	Value of a Division.
	1869.		gr.		gr.
(1)	Mar. 8	1000 ≏1000 B	+0·00003	No. 3.	0·00176
(2)	„ 9	1000 ≏1000 No. 1	+0·00300	„	0·00168
(3)	Feb. 10	1000 ≏600+300+100	+0·00028	„	0·00167
(4)	„ 8	600 ≏300+200+100	+0·00240	„	0·00182
(5)	„ 15	300 ≏200+100	+0·00150	„	0·00189
(6)	„ „	200 ≏100+100 No. 1	−0·00012	„	0·00211
(7)	„ „	100 ≏60+30+10	−0·00001	„	0·00186
(8)	Mar. 9	100 ≏100 No. 1	−0·00139	„	0·00172
(9)	Feb. 16	60 ≏30+20+10	+0·00188	„	0·00183
(10)	„ „	30 ≏20+10	+0·00103	„	0·00230
(11)	„ „	20 ≏10+10 No. 1	−0·00080	„	0·00196
(12)	„ 17	10 ≏6+3+1	−0·00050	„	0·00198
(13)	„ „	10 ≏10 No. 1	−0·00137	„	0·00187
(14)	„ „	6 ≏3+2+1	+0·00063	„	0·00188
(15)	„ „	3 ≏2+1	−0·00016	No. 4.	0·00095
(16)	„ 18	2 ≏1+1 No. 1	+0·00002	„	0·00096
(17)	„ 19	1 ≏0·6+0·3+0·1	−0·00004	„	0·00097
(18)	„ „	1 ≏1 No. 1	−0·00019	„	0·00099
(19)	„ 20	0·6 ≏0·3+0·2+0·1	−0·00078	„	0·00099
(20)	„ „	0·3 ≏0·2+0·1	+0·00017	„	0·00097
(21)	„ „	0·2 ≏0·1+0·1 No. 1	+0·00031	„	0·00095
(22)	„ „	0·1 ≏0·06+0·03+0·01	−0·00065	„	0·00097
(23)	Mar. 9	0·1 ≏0·1 No. 1	−0·00016	„	0·00183
(24)	Feb. 22	0·06≏0·03+0·02+0·01	−0·00066	„	0·00094
(25)	„ 23	0·03≏0·02+0·01	−0·00021	„	0·00094
(26)	„ „	0·02≏0·01+0·01 No. 1	−0·00011	„	0·00094
(27)	„ 24	0·01≏0·01 No. 1	+0·00014	„	0·00092
(28)	„ „	1000 ≏600+200+100+60+20+10+6+3+1	+0·00179	No. 3.	0·00170
(29)	„ „	Bullion 1 oz. ≏300+100+60+20	−0·00410	„	0·00157
(30)	„ „	„ 0·025 oz. ≏10+2	−0·00224	No. 4.	0·00095
(31)	Mar. 1	Gilt 500 B ≏300+200	+0·00108	No. 3.	0·00176
(32)	April 16	500 B +300+200≏1000 B	−0·00045	„	0·00168
(33)	„ „	„ „ ≏1000 No. 1	−0·00310	„	0·00185

Appendix V.—*continued.*

Results of Comparisons.

Results of Comparisons.	Denomination of Standard Decimal Grain Weights.	Actual Standard Weight.	Difference from Standard.
		gr.	gr.
(1) (2)	1000 =	1000·00158	+0·00158
(3) (4) (5) (6) (7)	600 =	600·00170	+0·00170
	300 =	300·00040	+0·00040
	200 =	199·99969	−0·00031
	100 =	99·99921	−0·00079
(8) (9) (10) (11) (12)	60 =	60·00019	+0·00019
	30 =	29·99967	−0·00033
	20 =	19·99928	−0·00072
	10 =	9·99936	−0·00064
(13) (14) (15) (16) (17)	6 =	6·00024	+0·00024
	3 =	2·99973	−0·00027
	2 =	1·99999	−0·00001
	1 =	0·99989	−0·00011
(18) (19) (20) (21) (22)	0·6 =	0·59978	−0·00022
	0·3 =	0·30019	+0·00019
	0·2 =	0·20040	+0·00040
	0·1 =	0·09996	−0·00004
(23) (24) (25) (26) (27)	0·06 =	0·06010	+0·00010
	0·03 =	0·03027	+0·00027
	0·02 =	0·02024	+0·00024
	0·01 =	0·01024	+0·00024
(31)	500 B =	500·00117	+0·00117

Proofs of these weighings,—

(28) 600 + 200 + 100 + 60 + 20 + 10 + 6 + 3 + 1 = 1000 − 0·00179 gr.
(1) (2) 1000 - - = 1000·00158

∴ 600 &c. - = 999·99979
From above 600 &c. - = 999·99929

Difference - = 0·00050

(29) 300 + 200 + 60 + 20 - = Bullion 1 oz. + 0·00410 gr.
Bullion 1 oz. Appendix V. p. 50 = - - - 479·99846

∴ 300 + 200 + 60 + 20 - = - - - 480·00256
From above, 300 + 200 + 60 + 20 = - - - 479·99908

Difference - - - 0·00348

(30) 10 + 2 - - - = Bullion 0·025 oz. + 0·00224
Bullion 0·025 oz. Appendix V. p. 50 = - - - 11·99846

∴ 10 + 2 - - = - - - 12·00070
From above, 10 + 2 - = - - - 11·99935

Difference - - - 0·00135

(32) 500 B + 300 + 200 - - = 1000 B - − 0·00045
1000 B - - - = - - - 1000·00150

∴ 500 No. 1 + 300 + 200 - = - - - 1000·00105
From above, 500 B + 300 + 200 = - - - 1000·00126

Difference - - - 0·00021

(33) 500 B + 300 + 200 - - = 1000 No. 2 − 0·00310
1000 No. 2 - - = - - - 1000·00464

∴ 500 B + 300 + 200 - = - - - 1000·00154
From above, 500 B + 300 + 200 = - - - 1000·00126

Difference - - - 0·00028

Verification of additional Grain Weights of 500, 50, 5, 0·5, 0·05 *grains.*

Verification of additional grain weights of 500, 50, &c. gr.

In accordance with the resolution of the Commission on 21st December 1869, that the new set of decimal grain weights should consist of the series 10, 5, 3, 2, 1, Mr. Oertling furnished this Department on 8th March 1870 with the following grain weights, to be substituted for the several weights of 600, 60, 6, 0·6, 0·06 grains each, at present in use. The weights of 600, 60, 6, 0·6, and 0·06 have accordingly been removed from the boxes of official grain standards, and these new weights substituted for them:—

	gr.	
A gilt gun-metal weight of	500	Decimal grain standards.
” ” ”	50	
” platinum weight of	5	
” aluminium weight of	0·5	
” ” ”	0·05	
A gun-metal weight of	500	Official standard set, No. 1.
” ” ”	50	
A platinum weight	5	
An aluminium weight	0·5	
” ” ”	0·05	

Appendix V.—*continued.*

Actual Comparison of additional Decimal Grain Weights.

Date.	No.	Compared.	Comparing.	Result in Divisions	Value of One Division.	Result in Grains.
1870.				div.	gr.	gr.
Mar. 10 -	(1)	Gilt 500	≏Gilt 300 +200	+6·4875	0·00082	+0·00536
" " -	(2)	"	≏No. 1 300 +200	+1·16125	0·00087	+0·00141
" " -	(3)	Gilt 50	≏Gilt 30 + 20	+2·48125	0·00091	+0·00227
" " -	(4)	"	≏No. 1 30 + 20	+0·14375	0·00094	+0·00014
" 14 -	(5)	Gilt 5	≏Gilt 3 + 2	+1·17500	0·00093	+0·00109
" " -	(6)	"	≏No. 1 3 + 2	+3·95000	0·00095	+0·00375
" " -	(7)	Gilt 0·5	≏Gilt 0·3 + 0·2	−1·13750	0·00092	−0·00104
" " -	(8)	"	≏No. 1 0·3 + 0·2	+1·14375	0·00094	+0·00108
" " -	(9)	Gilt 0·05	≏Gilt 0·03 + 0·02	+1·34375	0·00092	+0·00124
" " -	(10)	"	≏No. 1 0·03 + 0·02	−0·05625	0·00090	−0·00005
" 11 -	(11)	No. 1 500	≏Gilt 300 +200	+5·72500	0·00084	+0·00484
" " -	(12)	"	≏No. 1 300 +200	+2·24375	0·00077	+0·00172
" 12 -	(13)	No. 1 50	≏Gilt 30 + 20	+2·29375	0·00091	+0·00209
" " -	(14)	"	≏No. 1 30 + 20	+0·15625	0·00092	+0·00001
" 10 -	(15)	No. 1 5	≏Gilt 3 + 2	+0·13125	0·00094	+0·00012
" " -	(16)	"	≏No. 1 3 + 2	+3·08125	0·00091	+0·00281
" " -	(17)	No. 1 0·5	≏Gilt 0·3 + 0·2	+0·26250	0·00095	+0·00012
" " -	(18)	"	≏No. 1 0·3 + 0·2	+1·71250	0·00092	+0·00158
" 12 -	(19)	No. 1 0·05	≏Gilt 0·03 + 0·02	+1·05625	0·00097	+0·00103
" " -	(20)	"	≏No. 1 0·03 + 0·02	−0·33750	0·00094	−0·00032

Results of Comparisons.

Decimal Grain Weights.			Mean Standard Weight.	Ascertained Error.
		gr.	gr.	gr.
(1) Standard gilt - - - -	500	=500·00545	500·00569	+0·00569
(2) " - - - -	"	=500·00594		
(3) " - - - -	50	= 50·00222	50·00165	+0·00165
(4) " - - - -	"	= 50·00109		
(5) " - - - -	5	= 5·00081	5·00081	+0·00081
(6) " - - - -	"	= 5·00403*		
(7) " - - - -	0·5	= 0·49956	0·50007	+0·00007
(8) " - - - -	"	= 0·50009		
(9) " - - - -	0·05	= 0·04996	0·05003	+0·00003
(10) " - - - -	"	= 0·05011		
(11) Official Standard, No. 1, not gilt	500	=500·00492	500·00558	+0·00558
(12) " " "	"	=500·00625		
(13) " " "	50	= 50·00104	50·00107	+0·00107
(14) " " "	"	= 50·00110		
(15) " " "	5	= 5·00096	5·00096	+0·00096
(16) " " "	"	= 5·00309*		
(17) " " "	0·5	= 0·50071	0·50090	+0·00090
(18) " " "	"	= 0·50109		
(19) " " "	0·05	= 0·04975	0·05011	+0·00011
(20) " " "	"	= 0·05047		

* The official standard No. 1, three grain weight, used in comparisons (5) and (16) having been much used since its original reverification, when it was determined to be =3·00033 gr., has now been found to have become sensibly lighter. These two comparisons have therefore been discarded. This three grain weight has since been recompared, and its standard weight found to be 2·99868 gr.

Risk of losing these minute standard weights.

The smaller decimal grain weights have been in continual use for ascertaining the errors of local standard weights under comparison in the Department. From their very small size and peculiar form it is not easy to lay hold of them, and they are constantly liable to slip away from the small forceps or pincers used. Several of the smaller weights under a grain have thus been lost, and it has become necessary to replace them by others. In order to avoid the recurrence of this inconvenience, directions have been given that the greatest care be in future taken that no standard weight be thus dropped and lost, and that a sufficient number of additional small grain weights be supplied and verified for ordinary daily use as small balance weights, so that the standard set be used only for the comparison of copies of these standards.

New weights substituted.

The following standard weights have been carefully verified and substituted for weights so lost:—

——	Denomination.	Standard Weight.	Error.
	gr.	gr.	
Standard decimal grain weights, gilt.	0·06	0·06020	+0·00020
	0·03	0·02935	−0·00065
	0·02	0·01937	−0·00063
	0·01	0·00930	−0·00070
Official set, No. 1, not gilt -	0·06	0·05947	−0·00053
	0·03	0·03035	+0·00035
	0·02	0·01981	−0·00019
	0·01	0·00996	−0·00004

Appendix V.—*continued.*

Corrected list of decimal grain standard weights.

The following is a corrected list of the decimal grain weights proposed to be legalised as secondary standards, and their weight as actually determined :—

Corrected List of Decimal Grain Standard Weights.

Denomination.	Gilt Standard Weights for reference.		Official Standard Weights, No. 1.	
	Actual Weight.	Error.	Actual Weight.	Error.
gr.	gr.	gr.	gr.	gr.
1000	1000·00158	+0·00158	1000·00464	+0·00464
500	500·00569	+0·00569	500·00558	+0·00558
300	300·00040	+0·00040	300·00249	+0·00249
200	199·99969	−0·00031	200·00204	+0·00204
100	99·99921	−0·00079	100·00094	+0·00094
50	50·00165	+0·00165	50·00107	+0·00107
30	29·99967	−0·00033	30·00092	+0·00092
20	19·99928	−0·00072	20·00004	+0·00004
10	9·99936	−0·00064	10·00074	+0·00074
5	5·00081	+0·00081	5·00096	+0·00096
3	2·99973	−0·00027	2·99868*	−0·00132
2	1·99999	−0·00001	1·99995	−0·00005
1	0·99989	−0·00011	1·00002	+0·00002
0·5	0·50007	+0·00007	0·50090	+0·00090
0·3	0·30019	+0·00019	0·29975	−0·00025
0·2	0·20040	+0·00040	0·19976	−0·00024
0·1	0·09996	−0·00004	0·09995	−0·00005
0·05	0·05003	+0·00003	0·05011	+0·00011
0·03	0·02935	−0·00065	0·03035	+0·00035
0·02	0·01937	−0·00063	0·01981	−0·00019
0·01	0·00930	−0·00070	0·00996	−0·00004

* See note, page 63.

And the following weights of the former series will be available as auxiliary standards or balance weights :—

Denomination.	Gilt Weights.		Ungilt Weights, No. 1.	
	Actual Weight.	Error.	Actual Weight.	Error.
gr.	gr.	gr.	gr.	gr.
600	600·00170	+0·00170	600·00382	+0·00382
60	60·00019	+0·00019	60·00117	+0·00117
6	6·00024	+0·00024	5·99980	−0·00020
0·6	0·59978	−0·00022	0·59983	−0·00017
0·06	0·06020	+0·00020	0·05947	−0·00053

Reverification of Standard 10 *lb. Weight* (M) *and Original Verification of* 10 *lb.* (O).

Verificat of 10 lb. standar weights.

The error found on reverifying, in 1867, gilt gun-metal 10 lbs. standard M, originally verified by Professor Miller in 1854, was shown at p. 54 of Appendix V. to have been in excess 2·15525 grains. This standard has since been adjusted, as directed by the Commission at their seventh meeting on 26th February last, and it will be kept in the Department as a standard of reference.

An additional standard weight of 10 lbs., made of Baily's metal, but not gilt, has been constructed for departmental use by Mr. Oertling. It will be denoted as O.

In the reverification of M, and the original verification of O, they have both been compared with the same combination of gilt gun-metal standard weights GG, which were used on the former occasion in 1867, and then ascertained to weigh 0·25511 grains less than 10 lbs. (p. 53 of Appendix V.); they have also been compared with Kater's brass 10 lb. standard K. M, O, and K have also been separately compared with a combination of the four gilt gun-metal pounds, Nos. 31, 32, 33, and 34, together with their counterpoise C, and the counterpoise c of Nos. 31 and 32, both counterpoises being gilt gun-metal weights, and the whole being denoted as GCc.

Actual Comparisons of M *and* O *in* 1869.

No.	Date.	Number of Weighings.	Result of Weighings.		Value of 1 Division of Index of Balance No. 2.
	1869.			gr.	gr.
(1)	Sept. 10 - -	12	M≏GG - - -	+0·45848	0·10593
(2)	„ 6 - -	8	C≏lbs., Nos. 31, 32, 33, and 34	+0·01184	0·03644
(3)	„ „ - -	8	c ≏lbs., Nos. 31 and 32	−0·01548	0·04674
(4)	„ 7 - -	8	M≏GCc - -	+0·27329	0·05326
(5)	„ 4 - -	8	M≏K - - -	−0·06804	0·06680
(6)	„ 13 - -	8	O≏GG - - -	+0·50278	0·07189
(7)	„ 9 - -	8	O≏GCc - -	+1·11688	0·07898
(8)	„ 4 - -	8	O≏K - - -	+0·83278	0·06570
(9)	„ 7 - -	8	K≏GCc - -	+0·29968	0·07254

Differen in state values c one divi of balan

The differences in the value of a division of the index of the balance used in the preceding comparisons are not attributable to any fault of the balance, or errors of observation, several of the weighings having been tested by repeating them. They are found to arise principally from the resting point of the index needle, during the several weighings, being at a greater or less distance from the middle of the scale, where the pointer rests when the balance is in equilibrio. This will be seen from the following observations taken as illustrations of the fact stated :—

Balance No. 2.

—	Resting Position of Pointer.		Value of One Division of Index.	Resting Position of Pointer.		Value of One Division of Index.
	With 10 lbs. in each Pan.	With 0·3 Grain added to one Pan.		With 1 lb. in each Pan.	With 0·3 Grain added to Left Pan.	
(A) 1869, Sept. 6 -	31·275	40·	0·0355	26·65	43·	0·0181
(B) „ „ -	49·	53·675	0·0641	50·	59·	0·0333
(C) „ „ -	64·	75·75	0·0264	57·5	73·	0·0193

The scale is from 1 to 100, and thus the balance is found to be least sensitive, other things being equal, when the resting point is nearest to the middle of the scale, as in observation (B) of the preceding table. It is consequently desirable in all these weighings to allow a certain amount of oscillation to the balance.

Taking the standard weight of the compared standards, as previously found, to be as follows :— Grains.

GG=69999·74489
lbs. Nos. 31, 32, 33, and 34=27999·98262
Nos. 31 and 32=13999·98844
K=70000·29200

Appendix V.—*continued.*

the results of the preceding comparisons will be as follows:—

Results of Comparisons of M *and* O.

Results of Comparisons of M and O.

	Grains.		Grains.
(1)	M=70000·20337	(5)	M=70000·22396
(2)	C=27999·99446	(6)	O=70001·24756
(3)	c=13999·97296	(7)	O=70001·06681
	and GCc=69999·95004	(8)	O=70001·12478
(4)	M=70000·22333	(9)	K=70000·24972

As the bullion standards used to make up the weight of GG have been in continual use since 1867, and have probably slightly altered in weight, it is better to rest the value of M and O upon their comparisons with GCc, that is to say, on the four gilt gun-metal pounds which have been compared directly with the imperial standards; and it would therefore appear that—

	Grains.	Grains.	
The gilt gun-metal 10 lb. standard M .	=70000·22333 or	0·22333	too heavy.
The gun metal standard O	=70001·06681 or	1·06681	,,

The weight of Kater's brass 10 lb. standard K is evidently unaltered since its comparison with M in 1867, when it was found=70,000·292 grains, and its true standard weight may be taken as now determined=70,000·24972 grains.

		Grains.
From this last determination of	K=	70000·24972
and	M=	70000·22333
∴	M=K−	0·02639
By direct comparison	M=K−	0·06804

Considering that there is some difference in the density of M and of K, and in their densities as compared with those of the bullion standards, the slight discrepancy of 0·04165 grains in these results of the weighings of two standards of 70,000 grains each may be disregarded, and their true weight be accepted as above stated.

Re-adjustment and final determination of O.

On 26th October Mr. Oertling attended at the Standards Office under the Warden's directions, and re-adjusted O by opening the cavity in the bottom of the weight and removing about one grain.

The following further comparisons were subsequently made, eight weighings being taken for each comparison:—

No.	Date.	Compared Standard.	Comparing Standard.	Difference of Compared Standard in Divisions.	Value of One Division of Balance No. 2.	Difference of Compared Standard in Grains.
	1869			Div.	Grains.	Grains.
(10)	Nov. 4 -	O ≏	K	+7·60	0·03699	0·28112
(11)	,, 6 -	O ≏	M	+4·76	0·07091	0·33770

		Grains.
From (10)	O=	70000·56103
(11)	O=	70000·53084
∴ Mean	O=	70000·54593

All these results of the determination of the true standard weight of K, M, and O were reported to the Commission at the twenty-second meeting on 3rd December 1869 (Minutes, s. 8), and were accepted as satisfactory.

Re-adjustment and reverification of Standard Cubic Foot Weights of 62·321 *lbs.*

Re-adjustment and reverification of standard cubic foot weights of 62·321 lbs.

The large errors found in the standard 62·321 lbs. weight, and the three official copies Nos. 2, 3, and 4, as shown in Appendix V., pp. 55–7, were reported to the Standards Commission at the seventh meeting on 26th February 1869. In the meantime, the accuracy of the departmental comparison of the standard weight No. 1 had been confirmed by Professor Miller, who attended at the Standards Office on 22nd February for the purpose of re-comparing this standard with the same bullion standards as were used in the previous official comparisons in December 1868. Mr. Oertling, who was present at the weighings, having under the Warden's directions unscrewed the knob of No. 1, found in the cavity an adjusting weight of silver and a little metallic dust. No satisfactory explanation of the excess of the standard cubic foot weight and its three copies could be in any way found, either by Professor Miller or Mr. Oertling.

As sanctioned by the Commission, the four weights were taken away by Mr. Oertling to be adjusted to the true standard weight, and were returned so adjusted by him on 16th June 1869.

Upon re-comparing the standard 62·321 lb. weight No. 1 with a similar combination of bullion standards, it was found to be 1·20858 grains in excess, as reported to the Commission at the twenty-second meeting on 3rd December. But it was thought desirable to make some further weighings with a more exact counterpoise, both of the standard No. 1 and the three copies.

Actual comparisons of these weights.

The following comparisons for the final determination of the four standard weights have been made, eight weighings having been taken for each comparison:—

Comparisons of the Standard Cubic Foot Weights of 62·321 *lbs.* (*or* 436,247 *grs.*)

No.	Date of Comparison.	Compared Standard.		Comparing Standards.	Difference of Standards compared, in Divisions.	Value of 1 Division of Index of Balance No. 1.	Difference of Standards compared, in grains.
	1869.				div.	gr.	gr.
(1.)	Nov. 24 -	Standard 62·321 lbs. No. 1	≏	Bullion Standards (A), viz., 500, 400, 5, 3, 0·5, 0·3, 0·05, 0·005, oz. (=436248·93833 gr.) - - - -	−5·40	0·29507	−1·593
(2.)	Dec. 2 -	Do. + official weights of 30, 10, 6, 3, 2 grains (or 51·00174 gr.).	≏	Bullion Standards (B), viz., 500, 400, 5, 3, 0·5, 0·3, 0·1, 0·05, 0·004, oz. (=436296·45151 gr., as used in comparisons of Dec. 1868) -	+7·45	0·36925	+2·753
(3.)	,, 2 -	,, ,,	≏	,, ,, -	+3·54	0·33528	+1·188
(4.)	Nov. 25 -	Copy No. 2 - -	≏	Bullion Standards (A) -	−2·34	0·42762	−0·999
(5.)	,, 25 -	,, No. 3 - -	≏	,, ,, -	−5·74	0·29562	−1·698
(6.)	Dec. 17 -	,, No. 3 - -	≏	,, ,, -	−2·25	0·51259	−1·153
(7.)	Nov. 25 -	,, No. 4 - -	≏	,, ,, -	−6·66	0·37020	−2·466
(8.)	,, 27 -	,, No. 2 - -	≏	Standard No. 1 - -	−0·86	0·32638	−0·281
(9.)	,, 27 -	,, No. 2 - -	≏	,, - -	+1·64	0·46894	+0·768
(10.)	,, 27 -	,, No. 3 - -	≏	,, - -	+0·21	0·91388	+0·194
(11.)	Dec. 9 -	,, No. 4 - -	≏	,, - -	−1·79	0·48463	−0·866
(12.)	,, 9 -	,, No. 4 - -	≏	,, - -	−2·60	0·44925	−1·168

Appendix V.—*continued.*

The actual results of these comparisons of the cubic foot weights of 62·321 lbs. are as follows:—

—			Standard Weight.		Error, in grains.
	gr.		gr.	lbs.	gr.
(1.) Standard No. 1	=436247·340				
(2.) ,,	=436248·203				
(3.) ,,	=436246·638				
		Mean No. 1=	436247·394	or 62·32105	+0·394
(4.) Copy No. 2	=436247·934				
(8.) ,,	=436247·112				
(9.) ,,	=436248·162				
		Mean No. 2=	436247·736	or 62·32110	+0·736
(5.) Copy No. 3	=436247·236				
(6.) ,,	=436247·780				
(10.) ,,	=436247·589				
		Mean No. 3=	436247·535	or 62·32107	+0·535
(7.) Copy No. 4	=436246·467				
(11.) ,,	=436246·527				
(12.) ,,	=436246·376				
		Mean No. 4=	436246·457	or 62·32092	−0·543

Construction and verification of New Series of Fourteen Standard Weights of 1 lb.

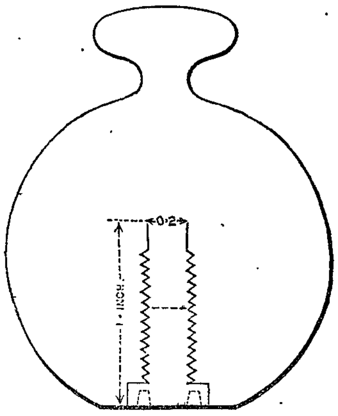
Construction of fourteen new 1 lb. standards.

The construction of this series of 1 lb. weights, to be carefully verified in relation to the imperial standard, and used in the Department as auxiliary standards in the verification of the larger standard weights, which are multiples of 1 lb., was approved by the Commission on 21st July 1869 (Minutes, s. 10).

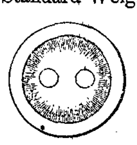
These new standards were made by Mr. Oertling, and delivered by him on 21st September 1869. These are constructed of Baily's metal, and are similar in form to the new set of avoirdupois standards, being spherical with a knob, and having a small cavity at the bottom, for adjustment, closed with a screw. They are numbered respectively from No. 35 to No. 48.

Form of new standard 1 lb. weight.

The following is the form and exact size of these new 1 lb. avoirdupois standard weights:—



New 1 lb. Standard Weight, No. 35.



Bottom of the 1 lb. weight, showing the pin holes for unscrewing.

The total height of this standard weight is 2·10 inch, and the greatest diameter 1·78 inch. The dimensions of the cavity in the 1 lb. weight, No. 35, beyond the end of the screw are 0·2 inch in diameter and 0·5 inch in depth; but it may be seen at p. 66 that the dimensions of the cavities vary in the several weights.

Calculations of Densities.

Observations for calculation of densities.

The verification of the new standard weights was began in December 1869, by comparing them with the new gilt gun-metal standards of 1 lb., Nos. 32 and 33. But before stating the details of the comparisons, the proceedings for calculating the density of each of these new weights, and the results, may be described.

This is the first attempt made in the Department to calculate the density of standard weights, and it was made by Mr. Chaney, who has not only followed the method adopted by Professor Miller for the numerous observations made by him during the construction of the imperial standard pound and its several copies, but has also had the advantage of consulting Professor Miller, and obtaining advice from time to time for his guidance. The whole of the details of Mr. Chaney's observations are recorded in the official books, but it may be sufficient here to describe their results, and the general course of proceeding.

It will be desirable that further observations may be made by the officers of the Department, as time will allow, in order that each officer may become familiar with the mode of calculating with accuracy the density of any standard weight. With this view, the results of the observations by weighings in water, may be checked by using the stereometer. This new instrument for the Department is now completed by Messrs. Troughton and Simms, but it cannot be used with precision without the aid of the cathetometer, the construction of which has also been authorised.

Formula for Calculation of Densities.

Formula fo calculating densities.

The formula for calculating the density of a standard weight is thus given by Professor W. H. Miller, in his account of the Construction of the Standard Pound (p. 792):—

"Let P in water at t° appear to weigh as much as Q in air. Then weight of water at t° displaced by P = weight of P − weight of Q + weight of air displaced by Q. Log. v P = log. weight in grains of the water displaced by P + log. W_t − log. $(1 + e\,Pt)$, where W_t is the ratio of the maximum density at t°, obtained from Table VI. Log. P = log. weight of P in grains − log. v P.

"An approximate value of v P having been found by assuming the weight of P equal to its apparent weight in air, this value of v P may be used in reducing the weight of P, and thus a more accurate value of v P obtained, by means of which a closer approximation to the values of the absolute weight of P and of Δ P may be found. This process is to be repeated when greater exactness is required."

Method of weighing adopted by Professor Miller.

Professor Miller's method of weighing standard weights in water, for the purpose of ascertaining their densities, and which has now been adopted in determining the densities of the new avoirdupois pounds of Baily's metal, was as follows:—

Miller, p. 794.

"The glass jar containing the distilled water in which the standard weight V was weighed, was 6·7 inches in diameter and 6·5 inches deep. V was suspended from the pan of the balance, by a hook attached to a fine copper wire, 7·5 inches of which weighed about 1 grain. In order to expel the air adhering in bubbles to the weight, or contained in the cavities, it was placed, with the fine wire attached to it, in water in a bell-shaped jar of thin glass, just large enough to contain the weight. The jar was suspended over the flame of a spirit lamp, by a stout wire bent at its lower end into a ring, into which the jar descended to its rim, and the water was allowed to boil till it was considered that the air was entirely expelled. The small jar containing the weight was then immersed in water, which very nearly filled the large jar, the suspending wire was hooked on to the under side of the scale pan, and the

Appendix V.—*continued.*

small jar was lowered till the weight hung clear of it and then removed. The transfer of the weight from the small jar to the large one was thus effected without taking it out of the water. The counterpoise was placed in the left-hand pan of the balance; V was suspended in water from the right-hand pan. Small weights were placed in the right-hand pan till equilibrium was produced, and the readings of the scale observed. V was then removed, leaving the hook suspended in water, and a volume of water equal to that of V was added to the water in the jar; the requisite weights were placed in the right-hand pan till the equilibrium was again produced, and the readings of the scale were observed. The thermometer B was suspended with its bulb in a horizontal plane through the centre of gravity of V. The thermometer C was in the balance case."

The standard weight thus weighed in water for ascertaining its density was the troy pound V, one of the brass standard pounds constructed in 1758, and which had several cavities or pores in the metal.

Apparatus for weighing in water, now used.

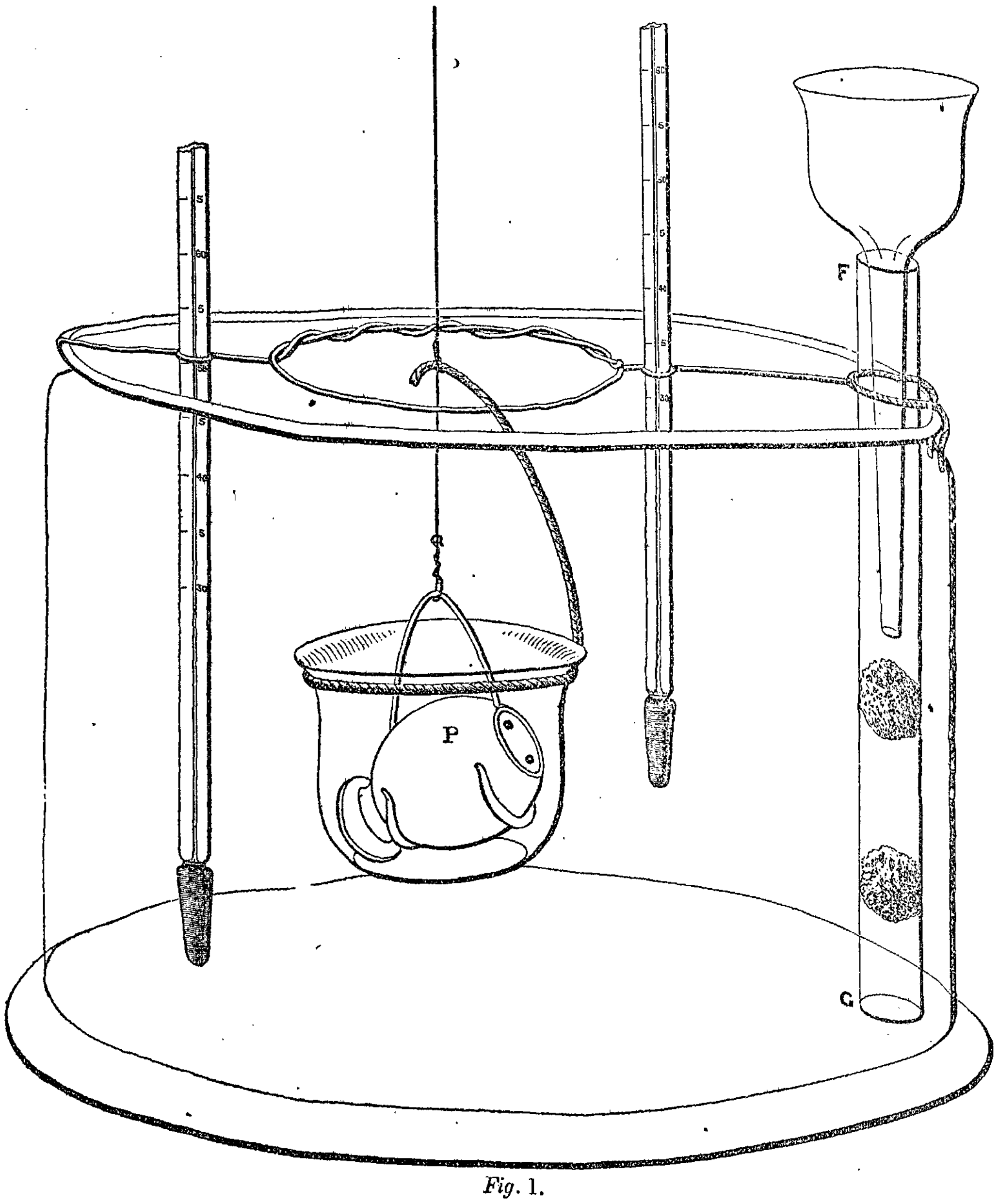


Fig. 1.

Figure 1 represents the glass jar (10 in. in diameter and 7 in. high), used in the Standards Department for weighing standard weights in water, with its apparatus for filling, and the two thermometers for ascertaining the temperature of the water at different heights, and shows also the small glass jar to be used when it is required to expel the air by boiling the weight in water.

The following precautions were taken, in accordance with Professor Miller's instructions, for filling the glass jar with distilled water:—

A glass tube FG (See Fig. 1), open at both ends and a little larger than the height of the glass jar, was attached to the side of the jar by a loop of wire. In this tube was inserted a glass funnel with a smaller tube having a small orifice. The jar was filled to the requisite height by pouring water into the funnel, the air bubbles being retained within the tube FG. When the surface of the water approached the standard weight P suspended in the jar, the water was poured very slowly into the funnel, and also when the water came near the upper part of P. As a further precaution against air bubbles it was considered better to put a piece of clean sponge into the tube FG at G.

When the surface of the weight is clear, boiling in water is not required. The standard weights with knobs were suspended in the middle of the jar by a double hook of stout wire fitted to the neck of the knob and round the cylinder, and attached to a loop in the fine copper wire, the base of the weight being uppermost. In order to cleanse the weight from any impurities, it was washed with alcohol. When boiling the weight in water was not required, any small bubble of air remaining upon the highest part of the weight was easily removed with a piece of fine wire. If the weight hung a little awry it was all the better, as then it was less likely to retain bubbles of air at its base.

It is found very important in determining densities, that the wire hook, by which the weight is suspended, should displace as little water as possible.

Tables of logarithms of ratios of maximum density of water.

The following tables of logarithms of the ratios of the maximum density of water to its ratio at each given temperature, according to the most authoritative observations, and assuming 3°·945 C. to be the temperature at which the density of water is at a maximum as determined by Playfair and Joule, is taken from Professor Miller's Account of the Construction of the Imperial Standard Pound, p. 791, and is used in the departmental computations for ascertaining the densities of standard weights.

Appendix V.—*continued.*

TABLE VI.

Logarithms of the ratios of the maximum density of water to its density at *t*, for every fifth of a centesimal degree.

t.	log. W_t.	Diff.	*t*.	log. W_t.	Diff.	*t*.	log. W_t.	Diff.	*t*.	log. W_t.	Diff.
3·945	0·0000000		9·4	0·0000939	68	14·8	0·0003580	128	20·0	0·0007544	178
4·2	0·0000002	5	9·6	0·0001007	72	15·0	0·0003708	130	20·2	0·0007722	180
4·4	0·0000007	7	9·8	0·0001079	73	15·2	0·0003838	132	20·4	0·0007902	181
4·6	0·0000014	10	10·0	0·0001152	76	15·4	0·0003970	134	20·6	0·0008083	183
4·8	0·0000024	12	10·2	0·0001228	78	15·6	0·0004104	136	20·8	0·0008266	185
5·0	0·0000036	15	10·4	0·0001306	80	15·8	0·0004240	138	21·0	0·0008451	186
5·2	0·0000051	18	10·6	0·0001386	82	16·0	0·0004378	140	21·2	0·0008637	189
5·4	0·0000069	20	10·8	0·0001468	85	16·2	0·0004518	142	21·4	0·0008826	190
5·6	0·0000089	22	11·0	0·0001553	87	16·4	0·0004660	144	21·6	0·0009016	191
5·8	0·0000111	25	11·2	0·0001640	89	16·6	0·0004804	146	21·8	0·0009207	193
6·0	0·0000136	28	11·4	0·0001729	92	16·8	0·0004950	148	22·0	0·0009400	196
6·2	0·0000164	30	11·6	0·0001821	94	17·0	0·0005098	150	22·2	0·0009596	197
6·4	0·0000194	33	11·8	0·0001915	96	17·2	0·0005248	152	22·4	0·0009793	198
6·6	0·0000227	35	12·0	0·0002011	98	17·4	0·0005400	154	22·6	0·0009991	200
6·8	0·0000262	37	12·2	0·0002109	100	17·6	0·0005554	155	22·8	0·0010191	202
7·0	0·0000299	40	12·4	0·0002209	103	17·8	0·0005709	158	23·0	0·0010393	203
7·2	0·0000339	42	12·6	0·0002312	104	18·0	0·0005867	159	23·2	0·0010596	205
7·4	0·0000381	45	12·8	0·0002416	107	18·2	0·0006026	161	23·4	0·0010801	207
7·6	0·0000426	48	13·0	0·0002523	109	18·4	0·0006187	164	23·6	0·0011008	208
7·8	0·0000474	50	13·2	0·0002632	111	18·6	0·0006351	165	23·8	0·0011216	210
8·0	0·0000524	52	13·4	0·0002743	114	18·8	0·0006516	166	24·0	0·0011426	211
8·2	0·0000576	54	13·6	0·0002857	115	19·0	0·0006682	169	24·2	0·0011637	213
8·4	0·0000630	57	13·8	0·0002972	117	19·2	0·0006851	171	24·4	0·0011850	215
8·6	0·0000687	60	14·0	0·0003089	120	19·4	0·0007022	172	24·6	0·0012065	216
8·8	0·0000747	61	14·2	0·0003209	122	19·6	0·0007194	174	24·8	0·0012281	217
9·0	0·0000808	64	14·4	0·0003331	124	19·8	0·0007368	176	25·0	0·0012498	
9·2	0·0000872	67	14·6	0·0003455	125						

Observations for determining density of standard 1 lb., No. 35.

Observations for determining density of Standard 1 *lb., No.* 35.

The following weighings were made by counterpoise, balance No. 3 being used. Eight readings were taken. The tables of logarithms used are those by Dupuis (Paris, 1870).

1 lb., No. 35, assumed = 7,000 grains in air; mean t = 64° 85, b = 29·915 in.

Date.	Weighings.	Result in Div.	Value of 1 Div.	Result in Grains.
1870. January 11	1 lb., No. 35, weighed in water ≏ Gilt grain weights, 4,000, 2,000, 100, 30, 10, 3, 0·3 gr. (or 6143·31221 gr.)	div. +19·975	gr. 0·03034	gr. +0·60604

		gr.
Weight of 1 lb., No. 35, in air,	t=64°·85, b=29·915 in.	= 7000·00000
„ in water,	t=60·09 „	= 6143·91825
		856·08175
Add Weight of air displaced by 6143·91825 gr. of bronze		+ 0·87335
∴ Weight of water displaced by 1 lb. No. 35.		856·95510

In computing the weight of air displaced by 6143·91825 gr. of gilt gun metal, the mean density of the gilt gun-metal lbs. Nos. 31 to 34, has been taken, the density of the gilt gun-metal grain weights not having been determined.

The gilt gun-metal grain weights were heavily electro-gilt in the same manner as the four gilt gun-metal lbs. Nos 31 to 34, by Messrs. Ladd and Streatfield. The mean density of these four weights is 8·49465, the extremes being 8·51472 and 8·47042. The mean density of the 30 gilt gun-metal lbs. Nos. 1 to 30, amalgam gilt by Barrow, is 8·20798, the extremes being 8·36500 and 7·97370, excluding two which are exceptional, the density of No. 17*b* being 8·55888, and of No. 9, 7·37614.

	gr.
Log. weight of water displaced	= 2·9329580
Add log. W_t.	+ 0·0004108
	2·9333688
Deduct log. $(1 + ePt)$	− 0·0003465
∴ log. v. 1 lb. No. 35	= 2·9330223
Deduct from log. weight in air of 1 lb. No. 35 in grains	− 3·8450980
∴ log. Δ 1 lb. No. 35	0·9120757
Whence Δ 1 lb. No. 35	= 8·16724

Appendix V.—*continued.*

This result is obtained by taking the nominal weight of 1 lb. No. 35, viz., 7,000 grains; a slight correction might be made, if necessary, by a more precise computation of its true weight in air of the specified temperature and pressure.

Table of densities of new standard 1 lb. weights.

The density of each of the new standard lbs., obtained by a similar method, the detailed observations being recorded in the books of the Department, is shown in the following table:—

Densities of New Avoirdupois Pounds of Baily's Metal, ungilt, 1870.

Standard Weight.	Density.	Log. Δ	Depth of Cavity containing Air, 0·2 in. diam.
			Inch.
lb. No. 35	8·16724	0·9120757	0·50
„ 36	8·24304	0·9160876	0·67
„ 37	8·25998	0·9169795	0·75
„ 38	8·23166	0·9154875	0·80
„ 39	8·28482	0·9182835	0·80
„ 40	8·37272	0·9228670	0·30
„ 41	8·34424	0·9213872	0·40
„ 42	8·28486	0·9182854	0·65
„ 43	8·26511	0·9172488	0·85
lb. No. 44	8·04662	0·9056136	0·95
„ 45	8·11136	0·9090941	0·95
„ 46	8·20055	0·9138430	0·35
„ 47	8·19183	0·9133812	0·64
„ 48	7·91141	0·8982542	0·32
Mean density -	8·20896		

It should be observed that the density of each of these standard weights is to some extent affected by the air contained in the closed cavity in the bottom, made for facilitating its adjustment. But their density is also materially affected by the mode of their casting, all the weights having been cast from the same pot of metal; and it is found practically that the density of the metal of the pound weight cast from the largest quantity of metal is the greatest.

Actual comparison of the new standard lb. weights.

The verification of the standard weight in air of these new standard 1 lb. weights, in terms of the commercial standard W, will now be described. The balance grain weights used are the official decimal grain weights, No. 1.

Comparisons of New Avoirdupois Pounds, 1869, *of Baily's Metal, with Gilt Pounds, Nos.* 32 *and* 33.

No.	Date.	Compared.	Comparing.	Result in Divisions.	Value of 1 Division, Balance No. 3.	Result in Grains.
	1869.		Grains.	Div.	Grains.	Grains.
(1)	Dec. 8 -	No. 35 - -	≏ No. 32 + 0·06 + 0·02 -	− 7·9875	0·00218	−0·01743
(2)	„ 9 -	„ 36 - -	≏ „ 33 - - -	− 2·9375	0·00183	−0·00539
(3)	„ „ -	„ 35 + 36 -	≏ „ 32 + 33 + 0·06 + 0·02 -	− 5·49375	0·00434	−0·02386
(4)	„ „ -	„ 35 - -	≏ „ 36 + 0·06 + 0·02 -	− 3·9	0·00269	−0·01049
(5)	„ 10 -	„ 37 - -	≏ „ 32 + 0·06 + 0·02 -	− 6·74375	0·00165	−0·01117
(6)	„ „ -	„ 38 - -	≏ „ 32 - - -	+ 8·0375	0·00225	+0·01809
(7)	„ „ -	„ 37 - -	≏ „ 38 + 0·06 - -	− 6·44375	0·00275	−0·01772
(8)	„ 11 -	„ 39 - -	≏ „ 32 - - -	+ 3·51875	0·00191	+0·00672
(9)	„ „ -	„ 40 - -	≏ „ 32 - - -	− 3·625	0·00230	−0·00835
(10)	„ „ -	„ 39 - -	≏ „ 40 - - -	+ 7·15625	0·00181	+0·01293
(11)	„ 14 -	„ 41 - -	≏ „ 32 + 0·03 - -	−11·00625	0·00235	−0·02586
(12)	„ „ -	„ 42 - -	≏ „ 32 + 0·03 - -	−10·1	0·00280	−0·02833
(13)	„ „ -	„ 41 + ·03 -	≏ „ 42 - - -	+10·43125	0·00260	+0·02714
(14)	„ 23 -	„ 43 - -	≏ „ 32 + 0·02 - -	− 9·45625	0·00244	−0·02303
(15)	„ „ -	„ 44 - -	≏ „ 32 + 0·06 + 0·02 -	− 2·7	0·00390	−0·01054
(16)	„ 27 -	„ 43 + ·06 + ·02 -	≏ „ 44 - - -	+ 0·80625	0·00367	+0·00296
(17)	„ 28 -	„ 45 - -	≏ „ 32 + 0·06 + 0·03 -	+ 2·125	0·00383	+0·00814
(18)	„ „ -	„ 46 - -	≏ „ 32 + 0·06 - -	− 1·2375	0·00314	−0·00388
(19)	„ „ -	„ 45 - -	≏ „ 46 + 0·03 - -	+ 4·0375	0·00359	+0·01449
(20)	„ 30 -	„ 47 - -	≏ „ 32 + 0·03 - -	− 2·3062	0·00292	−0·00673
(21)	„ „ -	„ 48 - -	≏ „ 32 + 0·1 + 0·03 + 0·02 -	+ 3·59375	0·00286	+0·01026
(22)	„ „ -	„ 47 + 0·1 + 0·03 -	≏ „ 48 - - -	− 1·01875	0·00270	−0·00275

Results of Comparisons.

No.	Results of Weighings.						Standard Weight in Air.	Ascertained Error.
	1 lb.		1 lb.	Grains.	Grains.		Grains.	Grains.
(1)	No. 35	=	No. 32	+0·06185 =	7000·06532			
(2)	„ 36	=	„ 33	−0·00539 =	6999·99343	Mean No. 35 =	7000·06428	+0·06428
(3)	„ 35 „ 36	=	„ 32 „ 33	+0·05542 =	14000·05771	Mean „ 36 =	6999·99399	−0·00601
(4)	„ 35	=	„ 36	+0·06879				

Appendix V.—*continued.*

No.	Results of Weighings.					Standard Weight in Air.	Ascertained Error.
	1 lb.		1 lb.	Grain.		Grains.	Grains.
(5)	No. 37	=	No. 32	+ 0·06811	- - - - - No. 37 =	7000·07158	+ 0·07158
(6)	„ 38	=	„ 32	+ 0·01809	- - - - - „ 38 =	7000·02156	+ 0·02156
(7)	„ 37	=	„ 38	+ 0·04174			
(8)	„ 39	=	„ 32	+ 0·00672	- - - - - „ 39 =	7000·01019	+ 0·01019
(9)	„ 40	=	„ 32	− 0·00834	- - - - - „ 40 =	6999·99513	− 0·00487
(10)	„ 39	=	„ 40	+ 0·01293			
(11)	„ 41	=	„ 32	+ 0·00449	- - - - - „ 41 =	7000·00796	+ 0·00796
(12)	„ 42	=	„ 32	− 0·00201	- - - - - „ 42 =	7000·00146	+ 0·00146
(13)	„ 41	=	„ 42	− 0·00320			
(14)	„ 43	=	„ 32	− 0·00322	- - - - - „ 43 =	7000·00025	+ 0·00025
(15)	„ 44	=	„ 32	+ 0·06873	- - - - - „ 44 =	7000·07220	+ 0·07220
(16)	„ 43	=	„ 44	− 0·07002			
(17)	„ 45	=	„ 32	+ 0·09796	- - - - - „ 45 =	7000·10143	+ 0·10143
(18)	„ 46	=	„ 32	+ 0·04559	- - - - - „ 46 =	7000·04906	+ 0·04906
(19)	„ 45	=	„ 46	+ 0·04484			
(20)	„ 47	=	„ 32	+ 0·02362	- - - - - „ 47 =	7000·02709	+ 0·02709
(21)	„ 48	=	„ 32	+ 0·16037	- - - - - „ 48 =	7000·16384	+ 0·16384
(22)	„ 47	=	„ 48	− 0·13305			

It was not until after the standard weight in air of these fourteen 1 lb. weights had been thus ascertained that they were weighed in water to determine their density. After this last process had been completed, the following five weights were directed to be re-adjusted, viz. :—

No. 35, 0·06428 gr. too heavy.
„ 37, 0·07158 „
„ 44, 0·07220 „
„ 45, 0·10143 „
„ 48, 0·16384 „

In accordance with the Warden's directions, Mr. Oertling attended at the Standards Department on 23rd February, and examined these five weights of 1 lb. previously to re-adjusting them. Their adjusting plugs were unscrewed and the cavities beneath carefully examined, in order to see whether there was any trace of the weights having been immersed in water, but nothing appeared to account for the errors in weight. Mr. Oertling attributed the increase of weight partly to oxidation, and he states that all these weights left his hands with no larger error than one or two one-hundredths of a grain. It may, however, be noticed that only four out of the 14 weights received on the same day have apparently gained so much in weight, although all the weights have been exposed to the same influences of oxidation, &c. It will probably be some years hence before these new fourteen gun-metal weights (Nos. 35 to 48), may have acquired, by exposure to the atmosphere, their maximum amount of oxidation, and it would be desirable to have them compared every year for some time to come in order to observe any variation of weight.

Reverification of five of the new weights after re-adjustment.

Reverification of Five of these Fourteen New Weights after Re-adjustment.

The following comparisons of these five pounds have been made after their re-adjustment:—

No.	Date.		Compared.	Comparing.	Result in Divisions.	Value of One Division of Balance No. 3.	Result in Grains.
	1870.				div.	gr.	gr.
(23)	Feb. 24	-	1 lb. No. 35 ≏	1 lb. No. 32	− 7·63125	0·00140	− 0·01069
(24)	„ „	-	No. 37 ≏	No. 32	+ 0·61250	0·00127	+ 0·00078
(25)	„ „	-	No. 44 ≏	No. 32	+ 5·43750	0·00115	+ 0·00626
(26)	„ „	-	No. 45 ≏	No. 32	+ 1·55000	0·00115	+ 0·00179
(27)	„ „	-	No. 48 ≏	No. 32	+ 1·47500	0·00133	+ 0·00196
(28)	Mar. 8	-	No. 35 ≏	No. 37	− 7·64375	0·00118	− 0·00904
(29)	„ 9	-	No. 37 ≏	No. 44	− 4·26250	0·00101	− 0·00431
(30)	„ „	-	No. 44 ≏	No. 48	+ 1·80625	0·00151	+ 0·00274
(31)	„ „	-	No. 45 ≏	No. 48	− 1·37500	0·00128	− 0·00177

Results of Comparisons.

—		Standard Weight in Air.	Error.
		gr.	gr.
From (23)	1 lb. No. 35 =	6999·99278	− 0·00722
(24)	No. 37 =	7000·00425	+ 0·00425
(25)	No. 44 =	7000·00973	+ 0·00973
(26)	No. 45 =	7000·00526	+ 0·00526
(27)	No. 48 =	7000·00543	+ 0·00543

Proofs—

		Grain.
(28)	1 lb. No. 35 = No. 37 −	0·00904
(23) (24)	No. 35 = No. 37 −	0·01147
	Difference =	0·00243
(29)	1 lb. No. 37 = No. 44 −	0·00431
(24) (25)	No. 37 = No. 44 −	0·00548
	Difference =	0·00117
(30)	1 lb. No. 44 = No. 45 +	0·00274
(25) (26)	No. 44 = No. 45 +	0·00447
	Difference =	0·00173

Appendix V.—*continued.*

		Grain.
(31)	1 lb. No. 45 = No. 48	−0·00177
(26) (27)	No. 45 = No. 48	−0·00017
	Difference	= 0·00160

Corrected Table of the standard weight of the fourteen new 1 lb. weights.

Corrected Table of the Standard Weight of the Fourteen new 1 lb. Weights.

New Official Avoirdupois Standard.	Standard Weight in Air.	Ascertained Error.
	gr.	gr.
1 lb., No. 35 -	6999·99278	−0·00722
No. 36 -	6999·99399	−0·00601
No. 37 -	7000·00425	+0·00425
No. 38 -	7000·02156	+0·02156
No. 39 -	7000·01019	+0·01019
No. 40 -	6999·99513	−0·00487
No. 41 -	7000·00796	+0·00796
No. 42 -	7000·00146	+0·00146
No. 43 -	7000·00025	+0·00025
No. 44 -	7000·00793	+0·00793
No. 45 -	7000·00526	+0·00526
No. 46 -	7000·04906	+0·04906
No. 47 -	7000·02709	+0·02709
No. 48 -	7000·00543	+0·00543

Construction and Verification of New Official Standards of Avoirdupois Weights.

Construction of new official standard avoirdupois weights.

In accordance with the suggestion at the conclusion of Part II. of this Appendix, and under the sanction of the Standards Commission as stated in the Minutes of 26th February 1869, a new set of standard avoirdupois weights has been constructed by Mr. Oertling, and has been verified in the Standards Department as a set of standards for reference. The order for the construction of these standards was given on 1st February 1869, and they were delivered at the Department on 19th July 1869.

The new standard weights are made of Baily's metal. They are of similar form to the official standards used for the ordinary departmental comparisons, being spherical with large knobs. There is a small cavity at the bottom of each weight to contain a minute adjusting weight, and it is closed with a screw, so as to be opened with a key when required. Each weight has its denomination marked upon it.

First comparison of 1 lb. weight and under.

The comparison and verification of these new standard weights has been effected by the same method as the ordinary official avoirdupois weights described in Paper V., being based on the three gilt gun-metal lbs. Nos. 32, 33, and 34, the standard weight of which *in* air was determined as follows (See App. V., p. 50):—

Gilt gun-metal lbs., No. 32=7000·00347 grains.
No. 33=6999·99882 „
No. 34=6999·99536 „

In the following comparisons, No. 1 to No. 13 were taken with balance No. 3, No. 14 to No. 23 with balance No. 4; twelve weighings were taken for each comparison. As a counterpoise or duplicate of each stated weight, one of the ordinary official avoirdupois standards of the same denomination, together with its supplementary weights to bring it to the standard, has been used; its standard weight can thus be again ascertained. These official standard weights, all of which are made of brass, are here distinguished as C, whilst the small supplementary weight of each is denoted as *s*.

First Comparison of New Avoirdupois Standards (from 1 lb. to ½ dram).

No.	Date of Comparison.	Results of Weighings.		Value of a Division of the Balance.
	1869.		gr.	gr.
(1)	Aug. 2	1 lb. - -	≏1 lb. No. 32−0·00513	0·00167
(2)	„ 3	1 lb. - -	≏1 lb. No. 33−0·00164	0·00166
(3)	„ 2	1 lb. - -	≏1 lb. No. 34+0·00174	0·00179
(4)	„ 5	1 lb. - -	≏1 lb. C + *s* +0·10376	0·00170
(5)	„ 5	8 oz. + 8 oz. C + *s*	≏1 lb. −0·08817	0·00188
(6)	„ 5	8 oz. - -	≏8 oz. C + *s* +0·08201	0·00159
(7)	„ 6	4 oz. + 4 oz. C + *s*	≏8 oz. −0·05757	0·00159
(8)	„ 6	4 oz. - -	≏4 oz. C + *s* +0·07072	0·00174
(9)	„ 6	2 oz. + 2 oz. C + *s*	≏4 oz. −0·02038	0·00180
(10)	„ 6	2 oz. - -	≏2 oz. C + *s* +0·01500	0·00192
(11)	„ 7	1 oz. + 1 oz. C + *s*	≏2 oz. −0·01194	0·00181
(12)	„ 7	1 oz. - -	≏1 oz. C + *s* +0·01366	0·00192
(13)	„ 7	8 dr. + 8 dr. C + *s*	≏1 oz. −0·03785	0·00188
(14)	„ 7	8 dr. - -	≏8 dr. C + *s* +0·04051	0·00087
(15)	„ 7	4 dr. + 4 dr. C + *s*	≏8 dr. −0·01293	0·00084
(16)	„ 7	4 dr. - -	≏4 dr. C + *s* +0·01349	0·00092
(17)	„ 9	2 dr. + 2 dr. C + *s*	≏4 dr. −0·02501	0·00092
(18)	„ 9	2 dr. - -	≏2 dr. C + *s* +0·02594	0·00093
(19)	„ 9	1 dr. + 1 dr. C + *s*	≏2 dr. −0·01531	0·00094
(20)	„ 9	1 dr. - -	≏1 dr. C + *s* +0·01830	0·00094
(21)	„ 9	½ dr. No. 1 + ½ dr. C + *s*	≏1 dr. −0·00224	0·00094
(22)	„ 10	½ dr. No. 1 -	≏½ dr. C + *s* +0·00327	0·00096
(23)	„ 10	½ dr. No. 2 -	≏½ dr. C + *s* +0·00296	0·00097

The results of these comparisons are as follows:—

Standard Weight of New Avoirdupois Standards (from 1 lb. to ½ dram).

		gr.	gr.
From (1)	1 lb.	=6999·99834	
(2)	1 lb.	=6999·99718	
(3)	1 lb.	=6999·99710	
Mean of (1) (2) (3)	1 lb.	=6999·99754 or	−0·00246
(5) (6)	8 oz.	=3499·99569	−0·00431
(7) (8)	4 oz.	=1750·00442	+0·00442
(9) (10)	2 oz.	= 874·99952	−0·00048
(11) (12)	1 oz.	= 437·50007	+0·00003
(13) (14)	8 dr.	= 218·74925	−0·00075
(15) (16)	4 dr.	= 109·37490	−0·00010
(17) (18)	2 dr.	= 54·68791	+0·00041
(19) (20)	1 dr.	= 27·34545	+0·00170
(21) (22)	½ dr. No. 1	= 13·67324	+0·00136
(23)	½ dr. No. 2	= 13·67293	+0·00115

These results have been tested by comparison No. 24, from which the ten weights under 1 lb. (the nominal weight of which is equal to 1 lb.) were found, when compared with the gilt gun-metal lb. No. 31 - =6999·98947 grains.
Their weight as determined above is =7000·00348 „
Difference - - - 0·00513 grain.

As the difference resulting from so many weighings amounted to less than three divisions of the balance index, these comparisons were then considered to be satisfactory.

Re-determination of old standards under 1 lb.

The standard weight of the following old avoirdupois standards, together with their supplementary weights, has been re-determined, from these comparisons, to be as follows:

Standard Weight of Official Standards of Avoirdupois Weight, with their Supplementary Weights.

From (4)	1 lb.	C + *s*	=6999·89378 or	−0·10622 gr.
(6)	8 oz.	„	=3499·91368	−0·08632
(8)	4 oz.	„	=1749·93370	−0·06630
(10)	2 oz.	„	= 874·98452	−0·01548
(12)	1 oz.	„	= 437·48641	−0·01359
(14)	8 dr.	„	= 218·73632	−0·01368
(16)	4 dr.	„	= 109·36141	−0·01359
(18)	2 dr.	„	= 54·43097	−0·25653
(20)	1 dr.	„	= 27·32715	−0·01660
(22)	½ dr.	„	= 13·66997	−0·00190

Appendix V.—*continued.*

The errors of these avoirdupois standard weights thus determined, as compared with the previous determination in January 1867, show the amount of their further deterioration from continued official use during a period of 2½ years.

Second comparison of the new official avoirdupois standards under 1 lb.

After the expiration of six months, when the 14 new standard weights of 1 lb. had been verified, and were ready for use in the verification of the larger weights of the new set of official avoirdupois standards above 1 lb., it was deemed desirable, whilst proceeding with the comparison of these larger weights, to make a second verification of the weights of 1 lb. and under, in order to observe whether any apparent variation had occurred in the weight of these new standards.

In the following comparisons the same counterpoises were used as before, consisting of the old official avoirdupois standards, C, and their supplementary weights, *s*. The balance weights were the official grain weights No. 1.

Second Comparison of new Official Avoirdupois Standards under 1 lb.

No.	Date.	Compared.	Comparing.	Balance used.	Value of 1 Division of Balance Index.	Results.	
						In Divisions.	In Grains.
	1870.				gr.	div.	gr.
(1)	April 1	1 lb. -	≏ 1 lb. gilt, No. 31 + 0·02 oz. -	No. 3	0·00127	− 0·84375	−0·00107
(2)	,,	1 lb. -	≏ 1 lb. gilt, No. 32 - -	,,	0·00154	− 0·9	−0·00138
(3)	4	1 lb. -	≏ 1 lb. gilt, No. 34 - -	,,	0·00137	+ 1·51875	+0·00209
(4)	,,	1 lb. -	≏ 1 lb. C + *s* + 0·06 + 0·03 gr. -	,,	0·00131	+ 12·5625	+0·01642
(5)	Feb. 21	1 lb. -	≏ 8 oz. + 8 oz. C + *s* + 0·06, 0·03, 0·01 gr.	,,	0·00125	− 6·93125	−0·00869
(6)	,,	8 oz. -	≏ 8 oz. C + *s* + 0·06, 0·03 gr. -	,,	0·00112	+ 1·10000	+0·00124
(7)	,,	8 oz. -	≏ 4 oz. + 4 oz. C + *s* + 0·06 gr. -	,,	0·00117	+ 5·63750	+0·00601
(8)	,,	4 oz. -	≏ 4 oz. C + *s* + 0·06, 0·02 gr. -	,,	0·00116	− 2·84375	−0·00331
(9)	22	4 oz. -	≏ 2 oz. + 2 oz. C + *s* + 0·03 gr. -	,,	0·00098	− 6·78750	−0·00666
(10)	,,	2 oz. -	≏ 2 oz. C + *s* + 0·01 gr. - -	,,	0·00119	+ 5·67500	+0·00677
(11)	,,	2 oz. -	≏ 1 oz. + 1 oz. C + *s* + 0·02 gr. -	,,	0·00118	− 5·21250	−0·00618
(12)	,,	1 oz. -	≏ 1 oz. C + *s* + 0·02 gr. - -	,,	0·00129	− 3·22500	−0·00418
(13)	24	1 oz. -	≏ 8 dr. + 8 dr. C + *s* + 0·03, 0·01 gr.	No. 4	0·00088	− 0·78125	−0·00069
(14)	,,	8 dr. -	≏ 8 dr. C + *s* + 0·03, 0·01 gr. -	,,	0·00092	− 2·15000	−0·00199
(15)	,,	8 dr. -	≏ 4 dr. + 4 dr. C + *s* + 0·01 gr. -	,,	0·00094	+ 3·36875	+0·00319
(16)	,,	4 dr. -	≏ 4 dr. C + *s* + 0·02 gr. - -	,,	0·00091	− 5·40000	−0·00494
(17)	,,	4 dr. -	≏ 2 dr. + 2 dr. C + *s* + 0·02 gr. -	,,	0·00892	+ 7·53125	+0·00672
(18)	,,	2 dr. -	≏ 2 dr. C + *s* + 0·03 gr. - -	,,	0·00095	− 3·30625	−0·00315
(19)	25	2 dr. -	≏ 1 dr. + 1 dr. C + *s* + 0·02 gr. -	,,	0·00092	− 4·28750	−0·00397
(20)	,,	1 dr. -	≏ 1 dr. C + *s* + 0·02 gr. - -	,,	0·00079	− 0·25625	−0·00020
(21)	,,	1 dr. -	≏ ½ dr. No. 1 + ½ dr. No. 2 -	,,	0·00094	+ 0·28750	+0·00027
(22)	,,	½ dr. No. 1	≏ ½ dr. No. 2 - - -	,,	0·00094	+ 0·77500	+0·00073
(23)	Mar. 4	8 oz. 4 2 1 8 dr. 4 2 1 No. 1 1 No. 2	≏ No. 31 + 0·02 gr. - -	No. 3	0·01064	+ 0·26280	+0·00279

Reductions of Comparisons.

			Grains.	
(1)		1 lb. =	7000·00371	
(2)		1 lb. =	7000·00428	
(3)		1 lb. =	6999·99745	
				Mean = 7000·00181
(4)	1 lb.	= 1 lb. C + *s*	+0·10624	∴ 1 lb. C + *s* = 6999·89557
(5)	8 oz. + 8 oz. C + *s*	= 1 lb.	−0·09109	
(6)	8 oz.	= 8 oz. C + *s*	+0·09106	
(7)	4 oz. + 4 oz. C + *s*	= 8 oz.	−0·06548	
(8)	4 oz.	= 4 oz. C + *s*	+0·07597	
(9)	2 oz. + 2 oz. C + *s*	= 4 oz.	−0·02369	
(10)	2 oz.	= 2 oz. C + *s*	+0·01643	
(11)	1 oz. + 1 oz. C + *s*	= 2 oz.	−0·01363	
(12)	1 oz.	= 1 oz. C + *s*	+0·01563	
(13)	8 dr. + 2 dr. C + *s*	= 1 oz.	−0·03962	
(14)	8 dr.	= 8 dr. C + *s*	+0·03832	
(15)	4 dr. + 4 dr. C + *s*	= 8 dr.	−0·01315	
(16)	4 dr.	= 4 dr. C + *s*	+0·01487	
(17)	2 dr. + 2 dr. C + *s*	= 4 dr.	−0·02653	
(18)	2 dr.	= 2 dr. C + *s*	+0·02720	
(19)	1 dr. + 1 dr. C + *s*	= 2 dr.	−0·01584	
(20)	1 dr.	= 1 dr. C + *s*	+0·01961	
(21)	½ dr. No. 1 + ½ dr. No. 2 - -	= 1 dr.	+0·00027	
(22)	½ dr. No. 1	= ½ dr. No. 2	+0·00073	

Appendix V.—*continued.*

Results of Comparisons.

New Official Avoirdupois Standard.	By Second Comparison.		By First Comparison.	Difference of Second Comparison.
	Standard Weight in Air.	Ascertained Error.	Ascertained Error.	
	Grains.	Grains.	Grains.	Grains.
1 lb. =	7000·00181	+0·00181	−0·00246	+0·00427
8 oz. =	3500·00089	+0·00089	−0·00431	+0·00520
4 oz. =	1750·00569	+0·00569	+0·00442	+0·00127
2 oz. =	874·99922	−0·00078	−0·00048	−0·00030
1 oz. =	437·50061	+0·00061	+0·00003	+0·00064
8 dr. =	218·74966	−0·00034	−0·00075	+0·00041
4 dr. =	109·37569	+0·00069	−0·00010	+0·00079
2 dr. =	54·68818	+0·00068	+0·00041	+0·00027
1 dr. =	27·34598	+0·00223	+0·00170	+0·00053
½ dr. No. 1 =	13·67349	+0·00162	+0·00136	+0·00026
½ dr. No. 2 =	13·67276	+0·00089	+0·00115	−0·00026

Allowing for probable errors of observations, the difference of weight on the second comparison of these new standard weights fairly shows a progressive increase of weight from oxidation in proportion to the exposed surface of the several weights.

Verification of the larger new Avoirdupois Standards, 2 lb. to 56 lb.

Comparisons of the larger standards, 2 lb. to 56 lb.

The verification of the new official avoirdupois standards from 2 lb. to 56 lb., which has been deferred until the verification of the 14 new pound weights of Baily's metal was completed, will now be described. The balance grain weights used were the official decimal grains, No. 1.

Actual Comparisons of new Standard Weights 2 lb. to 56 lb.

Date.	No.	Standard compared.	Comparing Weights.	Balance used.	Value of 1 Division of Balance.	Result	
						In Divisions.	In Grains.
1870.					gr.	div.	gr.
Mar. 1	(1)	2 lb.	≏No. 40 + 48 - - -	No. 3	0·00324	+ 7·20000	+0·02336
"	(2)	2 lb.	≏No. 32 + 33 - - -	"	0·00366	+ 5·21250	+0·01908
Feb. 28	(3)	4 lb.	≏Nos. 35, 41, 42, 44 + 0·1 gr. -	No. 2	0·06178	− 1·78125	−0·11004
"	(4)	4 lb.	≏Nos. 31, 32, 33, 34 + 0·01 gr. -	"	0·03823	− 2·15000	−0·08219
"	(5)	7 lb.	≏Nos. 35, 36, 41, 42, 43, 44, 45 + 0·6 gr.	"	0·07573	− 5·05625	−0·38291
"	(6)	7 lb.	≏Nos. 31, 32, 33, 34 + new 1 lb. + 2 lb. + 0·6 gr.	"	0·10178	− 6·46875	−0·65839
Mar. 4	(7)	14 lb.	≏Nos. 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48.	No. 1	0·06324	+12·43125	+0·78615
"	(8)	14 lb.	≏New 7, 4, 2, and 1 lb. - -	"	0·06349	+12·13750	+0·77061
"	(9)	28 lb.	≏New 14, 7, 4, 2, and 1 lb. + 6, & 0·6 gr.		0·08180	+ 5·97500	+0·48875
"	(10)	28 lb. + gilt lb. 32 and 33	≏10 lb. (O), 10 lb. (K), 10 lb. (M) + 6·0 gr.	"	0·06334	+12·81875	+0·81194
Mar. 5	(11)	56 lb. + gilt 1 lb. 32 and 33 + 6·0 gr.	≏10 lb. (O), 10 lb. (K), 10 lb. (M) + 28 lb.	"	0·11428	− 5·75000	−0·66711
" 7	(12)	56 lb. + 6·0 gr.	≏New 28, 14, 7, 4, 2, 1 lb. -	"	0·12499	+ 3·45000	+0·43125

Results of Comparisons.

No. of Comparison.	New Avoirdupois Standard.	Resulting Weight.	Mean Standard Weight.	Ascertained Error.
	lb.			
(1)	2 - - - -	= 14000·02392	14000·02265	+0·02265
(2)		= 14000·02137		
(3)	4 - - - -	= 28000·00586	28000·00312	+0·00312
(4)		= 28000·00038		
(5)	7 - - - -	= 49000·23237	49000·27785	+0·27785
(6)		= 49000·32332		
(7)	14 - - - -	= 98000·91431	98000·99303	+0·99303
(8)		= 98001·07176		
(9)	28 - - - -	=196008·38257	196008·10550	+8·10550
(10)		=196007·82843		
(11)	56 - - - -	=392002·46528	392003·14827	+3·14827
(12)		=392003·83114		

The excess of all these new weights was considered to be to some extent owing to their oxidation, and Mr. Oertling was directed to re-adjust the three larger weights of 14, 28, and 56 lbs. He attended for this purpose at the Standards Office on 12th March. The weights were re-adjusted by unscrewing the plugs of the cavities, which were again screwed in tightly after the re-adjustment by removing a small portion of the metal.

In the following re-comparison of these weights, balance No. 1 was again used.

Appendix V.—*continued.*

Re-comparison of new Official Standard Avoirdupois Weights 56, 28, *and* 14 *lbs.*

Date.	No.	Compared Standard.		Comparing Weights.	Result in Divisions.	Value of One Division.	Result in Grains.
1870.					Div.	Gr.	Gr.
March 17	(13)	14 lb.	≏	new gun-metal lbs. No. 35 to 48	+1·47500	0·08204	+0·12109
„ 18	(14)	14 lb.	≏	new 7, 4, 2, 1 lb.	+7·90000	0·08657	+0·68309
„ 18	(15)	28 lb. + gilt lb. Nos. 32, 33	≏	10 lbs., O. M. K.	−11·20000	0·12860	−1·44032
„ 17	(16)	28 lb.	≏	new 14, 7, 4, 2, 1 lb.	−0·95000	0·12600	−0·11875
„ 18	(17)	56 lb. + gilt lb. Nos. 32, 33	≏	10 lbs. O. M. K. + new 28 lbs.	−9·67500	0·21620	−2·09173
„ 17	(18)	56 lb.	≏	new 28, 14, 7, 4, 2, 1 lb.	−1·00006	0·12859	−0·12859

Results of Re-comparisons.

No. of Comparison.	New Avoirdupois Standards.		Resulting Weight.	Mean Standard Weight.	Ascertained Error.
			Gr.	Gr.	Gr.
(13) (14)	14 lb.	=	98,000·24962 98,000·98505	98,000·61733	+0·61733
(15) (16)	28 lb.	=	195,999·57637 196,000·79973	196,000·18805	+0·18805
(17) (18)	56 lb.	=	391,999·11301 392,000·97794	392,000·04547	+0·04547

The final results of the weighings of all these new official standard avoirdupois weights, and the ascertained error of each, will be found in the table contained in the following official minute:—

Minute, 4th April 1870.

Official Minute, or verification of new official standard avoirdupois weights.

The verification in the Standards Department of the new set of official standards of avoirdupois weight has this day been completed, the standard weight in air of each weight and the ascertained error being as follows :—

New Official Avoirdupois Standards. 1870.

Denomination.	Mean Standard Weight.	Ascertained Error.
	gr.	gr.
56 pounds - - -	392000·04547	+0·04547
28 „ - - -	196000·18805	+0·18805
14 „ - - -	98000·61733	+0·61733
7 „ - - -	49000·27785	+0·27785
4 „ - - -	28000·00312	+0·00312
2 „ - - -	14000·02265	+0·02265
1 „ - - -	7000·00181	+0·00181
8 ounces - - -	3500·00089	+0·00089
4 „ - - -	1750·00569	+0·00569
2 „ - - -	874·99922	−0·00078
1 „ - - -	437·50061	+0·00061
8 drams - - -	218·74966	−0·00034
4 „ - - -	109·37569	+0·00069
2 „ - - -	54·68818	+0·00068
1 „ - - -	27·34598	+0·00223
½ „ No. 1 - -	13·67349	+0·00162
½ „ No. 2 - -	13·67276	+0·00089

The Warden of the Standards now directs that this new set be used for all the official comparisons of copies of the standard avoirdupois weights.

He has given directions to Mr. Oertling to re-adjust each weight of the set of the old avoirdupois standards constructed in 1825, as nearly as possible to its true weight. As this old set is of brass, and the surface of the weight is now much oxidized, so that there will probably be little variation in weight from further oxidation, this old set of official standard avoirdupois weights, 1825, will be kept as standards for reference. There will thus be a ready means of ascertaining from time to time any alteration in the weight from oxidation of the new standard set, though such increase will be to a certain extent compensated by the loss of weight from friction in use.

The set of brass counterpoises of the old avoirdupois standards will also be re-adjusted to their true weight by Mr. Oertling, as soon as he shall have completed the re-adjustment of the old standard set.

Before sending the old official standard avoirdupois weight for re-adjustment, the following comparison was made of the 56 lb. with the new 56 lb. standard weight, balance No. 1 being used :—

Date.	Weighings.	Result in Division.	Value of One Division.	Result in Grains.
1870. April 7 -	56 lb. C + 6 gr. + 3 gr. ≏ new 56 lb.	−19·15	0·2162	−4·14023

Whence 56 lb. C=new 56 lb. −13·14036 gr., or 56 lb. C =391986·905 grs., being 13·095 grs. less than its true standard weight.

As the 56 lb. C was found on 10th October 1867 to be 11·856 grs. deficient, it would appear to have lost 1·239 grs. by continued use in the Department during the intervening period of 2¾ years.

It was also found from the last comparison of 1 lb. C, that, after deducting the supplementary weight *s*, 1 lb. C= 6999·043 grs., or 0·957 grs. in deficiency. As it was found to be 0·850 grs. deficiency in 1867, it would appear to have lost on weight 0·107 grs. since 1867.

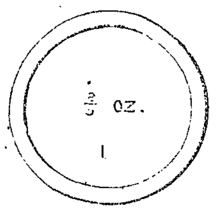
H. W. Chisholm, Warden.

Construction and Verification of new Standard ⅓ and ⅔ oz, Weights for Foreign Postal Services.

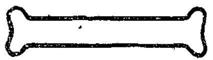
A series of three new weights of ⅓ oz. and of ⅔ oz. respectively has been constructed by Messrs. De Grave and Co., and these new weights were delivered at the Standards Department on 29th March 1870.

Appendix V.—*continued.*

They are of Baily's metal and of the following form and size, having a slight groove round them, and each denomination being marked 1, 2, and 3 respectively.



Plan of $\frac{2}{3}$ oz. Postal
Standard weight.



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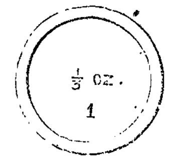
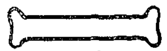


Plan of $\frac{1}{2}$ oz. Postal
Standard weight.



Section of above.

These weights have been verified by comparison with the new official avoirdupois standards of 1 oz. and 2 oz., the weight of which has been determined to be 437·50061 gr., and 874·99922 gr. respectively.

Actual Comparisons of new Weights of $\frac{1}{3}$ and $\frac{2}{3}$ oz.

No.	Date.	Weighings.		Difference in Divisions.	Balance used.	Value of One Div. of Balance.	Difference in Grains.
	1870.			div.		gr.	gr.
(1)	Mar. 30	$\frac{2}{3}$ oz. Nos. 1, 2, 3 + 0·03 gr.	≏ 2 oz.	+1·31875	No. 3	0·00101	+0·00133
(2)	„	„ No. 1	≏ $\frac{2}{3}$ oz. No. 2	+2·90625	„	0·00130	+0·00378
(3)	„	„ No. 1	≏ „ No. 3	+1·18750	„	0·00129	+0·00153
(4)	„	$\frac{1}{3}$ oz. Nos. 1, 2, 3, + 0·02 gr.	≏ 1 oz.	+3·46215	No. 4	0·00087	+0·00300
(5)	„	„ No. 1	≏ $\frac{1}{3}$ oz. No. 2	−0·77500	„	0·00091	−0·00071
(6)	„	„ No. 1	≏ $\frac{1}{3}$ oz. No. 3	−0·50625	„	0·00096	−0·00048
(7)	„	$\frac{2}{3}$ oz. No. 1 + $\frac{1}{3}$ oz. No. 1 + 0·02 gr.	≏ 1 oz.	+3·63125	No. 3	0·00126	+0·00046
(8)	„	$\frac{2}{3}$ oz. No. 2 + $\frac{1}{3}$ oz. No. 2 + 0·02 gr.	≏ 1 oz.	+2·35000	„	0·00129	+0·00304
(9)	„	$\frac{2}{3}$ oz. No. 3 + $\frac{1}{3}$ oz. No. 3. + 0·02 gr.	≏ 1 oz.	+3·86250	„	0·00126	+0·00488

gr.
(1) $\frac{2}{3}$ oz. No. 1 + No. 2 + No. 3 = 874·97020
(2) $\frac{2}{3}$ oz. No. 1 = No. 2 + 0·00378
(3) $\frac{2}{3}$ oz. No. 1 = No. 3 + 0·00153

∴ 3 of $\frac{2}{3}$ oz. No. 1 = 874·97551

And $\frac{2}{3}$ oz. No. 1 = 291·65850 or − 0·00816
No. 2 = 291·65472 − 0·01194
No. 3 = 291·65697 − 0·00969

(4) $\frac{1}{3}$ oz. No. 1 + No. 2 + 3 = 437·48380
(5) $\frac{1}{3}$ oz. No. 1 = No. 2 − 0·00071
(6) $\frac{1}{3}$ oz. No. 1 = No. 3 − 0·00048

∴ 3 of $\frac{1}{3}$ oz. No. 1 = 437·48261

And $\frac{1}{3}$ oz. No. 1 = 145·82754 or − 0·00579
No. 2 = 145·82825 − 0·00508
No. 3 = 145·82802 − 0·00531

(7) $\frac{2}{3}$ oz. No. 1 + $\frac{1}{3}$ oz. No. 1 = 437·48600
From above = 437·48604

Difference = 0·00004

(8) $\frac{2}{3}$ oz. No. 2 + $\frac{1}{3}$ oz. No. 2 = 437·48384
From above = 437·48297

Difference = 0·00087

(9) $\frac{2}{3}$ oz. No. 3 + $\frac{1}{3}$ oz. No. 3 = 437·48563
From above = 437·48499

Difference = 0·00064

Upon these new weights of $\frac{1}{3}$ and $\frac{2}{3}$ oz. being submitted to the Commission at their meeting on 2nd April, they objected to the groove round them, such being the distinctive form which had been approved by the Commission for weights of the metric system. It was resolved therefore that two new weights of $\frac{1}{3}$ and $\frac{2}{3}$ oz. respectively should be constructed of a similar form but without the groove, in order that they might be constituted the standards of these denominations. The weights with a groove would remain available as auxiliary standards or counterpoises for departmental comparisons.

Appendix V.—*continued.*

The two new weights of $\frac{1}{3}$ and $\frac{2}{3}$ oz. were delivered at the Standards Department by Messrs. De Grave and Co. on 8th April. They have no groove on the sides, and are nearly flat at the bottom. They have been verified as follows, balance No. 4 being used :—

Comparisons of New Standard Weights of $\frac{1}{3}$ and $\frac{2}{3}$ oz.

No.	Date.	Weighings.	Difference in Divisions.	Value of One Division.	Difference in Grains.
	1870.		div.	gr.	gr.
(10)	April 8 -	Standard $\frac{1}{3}$ oz. ≏ gilt gr. 100 + 30 + 10 + 5 + 0·5 + 0·3 + 0·03 (or 145·82866 grs). -	+ 12·60625	0·00094	+ 0·01188
(11)	„ -	„ „ ≏ $\frac{1}{3}$ oz. No. 1 - - -	+ 11·35	0·00094	+ 0·01068
(12)	„ -	Standard $\frac{2}{3}$ oz. ≏ gilt gr. 200 + 50 + 30 + 10 + 1 + 0·5 + 0·1 + 0·05 + 0·01 (or 291·66027 grs.) - - - -	+ 20·76875	0·00093	+ 0·01921
(13)	„ -	„ „ ≏ $\frac{2}{3}$ oz., No. 2 - - -	+ 1·2875	0·00084	+ 0·00108

Gr.
From (10) Standard $\frac{1}{3}$ oz. = 145·84054
„ (11) „ = 145·83822
„ (12) Standard $\frac{2}{3}$ oz. = 291·67948
„ (13) „ = 291·67561

Hence by assigning twice the value to the comparison with the gilt grain standards, the mean weight of the two new standards of $\frac{1}{3}$ and $\frac{2}{3}$ oz. may be determined as follows :—

	Gr.		Gr.
Standard $\frac{1}{3}$ oz. =	145·83976	or	+ 0·00643
„ $\frac{2}{3}$ oz. =	291·67819	or	+ 0·01153

H. W. CHISHOLM,
Warden.

Standards Office,
8th April 1870.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—On the STANDARD for COINS, including CONSTRUCTION and VERIFICATION of NEW STANDARD WEIGHTS.

PART IV.—PROVISIONS of COINAGE ACT, 1870, relating to STANDARD WEIGHTS for COIN.

CONTENTS.

Page
Provisions of s. 17 of Coinage Act, 1870, as to Standard weights for coins - - - - - - 76
Powers and duties of Board of Trade - - - „
Description of Standard weights for coins :
  1. Decimal bullion weights - - - - „
  2. Pyx Troy weights - - - - „
  3. New weights of coins and multiples of sovereign weights only requisite, probable number - - 77
  4. Decimal grain weights - - - „
Substitution of millième report for carats and grains, in assays - - - - - - - „
New duty of Standards Department to verify weights for the public - - - - - - „
Mode of official verification of weights for coins - - „
Method of stamping or marking weights - - - „

Page
Certificate of verification - - - - - 78
Fees of verification - - - - - „
Penalties imposed on offences relating to the Stamp - „
Description of coin weights now used:
  Bankers' sovereign weights - - - - „
  Various weights of single coins - - - „
  Weighing apparatus for coins - - - „
As to inspections of coin weights:
  Existing powers of Inspectors of Weights and Measures „
  Not extending to coin weights - - - „
  Nor required for the protection of the public - - „
  But heavy liability now proposed on shop keepers - „
  Suggested alteration - - - - - „
Conclusion - - - - - - „

Provisions of s. 17 of Coinage Act.

The provisions of the Coinage Act, 1870, which relate to the standard weights of the coins of the realm, are contained in s. 17.

Powers and duties of Board of Trade.

The construction, verification, and custody of all standard weights for weighing and testing the coin of the realm, and weights of each coin, and such multiples as may be required, are entrusted to the Board of Trade, and the duties are to be performed by the Standards Department; the legalisation of all such new standard weights, when duly verified, being effected by Order in Council.

The comparison, verification, and stamping or marking of such standard weights for coins, and regulation of the fees payable, are also similarly entrusted to the Board of Trade.

Description of standard weights for coin: 1. Decimal bullion weights.

These standard weights are of the following descriptions :—

1. The decimal bullion weights, now in the Standards Department, are 32 in number, from 500 Troy oz. to 0·001 oz. They have been recently re-verified and the standard weight of each accurately determined, as shown in Paper X.–1, p. 13. Verified copies of these bullion standards are used at the Mint for weighing bullion for coinage, and are re-verified from time to time when required.

2. Troy pyx weights.

2. The series of Troy weights, nine in number, from 1 lb. or 12 ozs. to 30 lbs. or 360 ozs., specially constructed for weighing the coin at the Trial of the Pyx. Their verification is described at p. 54 of App. V.

These Pyx weights, as well as the original set of Troy standards, from 1lb. to 1 gr., being 15 in number, are also now in the Standards Department. The Standards Commission have recommended in their Third Report that all these Troy weights, including the decimal bullion weights, should cease to be legal standards, and Troy weight abolished, metric weights being substituted for Mint purposes. But before this can be done, the necessary legislative provisions must be made and the official requirements provided for. A complete set of metric weights, accurately verified in terms of the Primary Standard at Paris, is now in the Standards Office.

Appendix V.—*continued.*

3. New weights of coins and multiples.

3. The following standard weights of coins are now required to be made under the first Schedule, p. 9, of the Coinage Act:—

Denomination of Coin.	Standard Weight.		Least Current Weight.	
	Imperial Weight. Grains.	Metric Weight. Grams.	Imperial Weight. Grains.	Metric Weight. Grams.
GOLD:				
Five Pound - - -	616·37239	39·94028	612·50000	39·68935
Two Pound - - -	246·54895	15·97611	245·00000	15·87574
Sovereign - - -	123·27447	7·98805	122·50000	7·93787
Half Sovereign - -	61·63723	3·99402	61·12500	3·96083
SILVER:				
Crown - - -	436·36363	28·27590	—	—
Half Crown - - -	218·18181	14·13795	—	—
Florin - - -	174·54545	11·31036	—	—
Shilling - - -	87·27272	5·65518	—	—
Sixpence - - -	43·63636	2·82759	—	—
Groat or Fourpence - -	29·09090	1·88506	—	—
Threepence - - -	21·81818	1·41379	—	—
Twopence - - -	14·54545	0·94253	—	—
Penny - - -	7·27272	0·47126	—	—
BRONZE:				
Penny - - -	145·83333	9·44984	—	—
Halfpenny - - -	87·50000	5·66990	—	—
Farthing - - -	43·75000	2·83495	—	—

Full legal weight.	Gold coins	4	standard weights.
	Silver ,,	9	,,
	Bronze ,,	3	,,
Least current weight.	Gold ,,	4	,,
Total - -		20	

and such multiples as may be required.

As to multiples of the sovereign.

With respect to the question of constructing and legalising multiples of such standard coin weights, it is obvious that multiples of the sovereign weight alone are now in any way required. It is only in the gold coinage that the legal current weight of coins is limited by s. 4 of the Coinage Act of the first schedule. The following scale of multiples which might be completed by the weights of five and two sovereigns contained in the Schedule to the Act, has already been proposed in App. 2, p. 10.

Standard weights of	100	sovereigns.
,,	50	,,
,,	40	,,
,,	30	,,
,,	20	,,
,,	10	,,
,,	4	,,
,,	3	,,
Total - -	8	weights.

This decimal series of gold coin weights *of the full legal weight* has been recommended to be legalised as standards in s. 6 of the First Report of the Standards Commission. It may now remain for consideration whether a similar series of standard weights of gold coins *of least current weight* should also be adopted. I am endeavouring to procure further and more precise information to lay before the Commission, as to the multiple weights of sovereigns actually needed.

4. Decimal grain weights.

A fourth description of standard weights may also be mentioned as convenient for ascertaining minute differences in coins, the series of decimal grain weights, from 1,000 grains to 0·01 grain; the grain being now a legal Avoirdupois weight. This series was also recommended in s. 6 of the First Report of the Standards Commission to be legalised as standards. It is suggested that they should be thus legalised by Order in Council, together with the new coin weights. The whole series of decimal grain weights has now been accurately verified, including the substitution of 5 for 6 in the decimal scale 6, 3, 2, 1, of which the verification has been shown at App. V., p. 64, this substitution being in pursuance of the Resolution of the Commission recorded in s. 5 of the Minutes of 21st Dec. 1869. These decimal grain weights will be useful for other purposes than for weighing coin, particularly for assays and chemical analysis.

Substitution of millième report for carats and grains in assays.

With respect to the assay of bullion, it was announced by the Governor of the Bank on 18th March, that the Directors have resolved to disuse the trade report, hitherto expressed in carats, grains, and eighths of grains, and to adopt a quotation expressed in thousandths and thirds of thousands. The effect of this resolution will be that the fineness of gold bars sent to the Bank will be calculated to $\frac{1}{3000}$th part instead of $\frac{1}{1768}$th, as heretofore.

New duty of Standards Department to verify weights for the public.

The transfer from the Mint to the Standards Department of the duty of verifying coin weights used by the public by comparison with the standards is a new duty, as, hitherto, such verifications have been made only for Inspectors of Weights and Measures, or public offices or departments, no fee being charged. An extension of the departmental duties, to the verification of all weights and measures, in which special accuracy is required, on payment of a proper fee, has already been recommended by the Standards Commission in s. 14 of their First Report, but a legislative enactment is required for charging such a fee. The official regulations for verifying coin weights may serve as a precedent for the performance of the more extended duties so recommended by the Commission.

Mode of official verification of weights for coins.

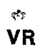
The mode now adopted in the Standards Department of comparing, verifying, and stamping or marking copies of the standard weights for the use of Inspectors of Weights and Measures, and of certifying and recording their verification, may be adopted for copies of the standard weights for coins, with some modifications.

A requisition should be delivered with the weights to be compared, printed forms of which may be obtained at the Standards Department. The requisition should specify the date of delivery, the number and denominations of the weights to be compared, and the name and address of the officer or person to whom they belong. A corresponding printed form of receipt should be given upon their delivery, the production of which should be a sufficient authority for their return, when verified.

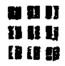
Method of stamping or marking weights.

For coin weights of the sovereign and half sovereign, which alone are required to be used by the public, the mark of verification may be a stamp upon each metallic weight, made by a die by means of a hand press; this method having hitherto been used at the Mint and found satisfactory. In the case of the verification of copies of the Standard coin weights generally, as well as of copies of any others of the Standard weights and measures, which may be required, the mode of stamping or marking them may be by a steel punch with the blow of a hammer, as at present. If glass weights are authorized, the mode of marking them will require further consideration.

The following stamps are now used:—

1. 

The Crown, with the initials of the Sovereign.

2. 
The Chequers, or Portcullis, being the old Exchequer mark.

3. **2358** The registered number of the set of weights, corresponding with the number of the Indenture of Verification.

There are eight different sizes of the first description of stamp, nine of the second, and four of the third.

It may be expedient that the old Exchequer mark of the chequers should now be discontinued in all official verifications, and the stamp of the Crown and initials of the Sovereign alone constitute the official mark of verification.

Appendix V.—*continued.*

Three different sizes would suffice, both of this mark and of the registering number, for all purposes.

The following are the four sizes of the numbers now used:—

6 6 6 6

Some of these are indistinct, and their form is very open to improvement. It is difficult to distinguish between the figures 3 and 8. The same stamp is used for both 6 and 9. I propose to have new numbering stamps made with the figures as designed by Colonel Strange, to which the attention of the Commission will be drawn more in detail when describing the revolving drill apparatus proposed for marking measures of length and capacity.

Certificate of verification.

Instead of the indenture of verification, issued with all copies of the standards verified for the use of Inspectors of Weights and Measures, which is a formal document or parchment, producible in a court of justice as proof of the weights, &c. being duly verified according to law, a brief certificate of verification of coin weights should be given. Under s. 17 of the Coinage Act the fees for verification are to be taken in money, which is to be paid into the exchequer and carried to the Consolidated Fund. I have already suggested to the Board of Trade that it would be a better plan to levy the fee by a stamp upon the certificate of verification. But this is a question for the Treasury to decide, they being already empowered under the provisions of 29 & 30 Vict. c. 76. to make regulations for collecting all such official fees by means of stamps.

Fees of verification.

The amount of verification fees, not exceeding five shillings for each set, is to be regulated from time to time by the Board of Trade, and notified in the London Gazette. The fixing of the amount of the fee will require some consideration. If large numbers of these coin weights should be wanted by the public, their verification and stamping might perhaps be effected by the local verifiers or Inspectors of Weights and Measures, who would require to be provided with copies of the Standards for this purpose, charging a small fee only. In such case the necessary provision may be made in the Bill recommended by the Commission to be introduced by the Government for amending and consolidating the Weights and Measures Laws. A verification in the Standards office is needed only for copies of the Standards, where special accuracy is required, and a higher fee may be charged, and not for ordinary commercial weights. But no fee should be levied on the verification of copies of the Standard weights for coin for the use of the local inspectors, or the Mint, or other public department.

Penalties imposed on offences relating to these stamps.

S. 17 of the Coinage Bill requires all weights for determining the weight of gold and silver coins of the realm to be duly stamped, and imposes a penalty not exceeding 50*l.* on any person convicted of counterfeiting such stamp; of wilfully altering a weight so stamped; of knowingly using a weight with such counterfeited stamp or altered weight; or knowingly using any coin weight not duly stamped.

Descriptions of coin weights now in use. Bankers' sovereign weights.

There are two descriptions of coin weights now commonly in use.

The first description is that used by bankers for checking the number of sovereigns received or paid by them, either before or after they are counted. A decimal series of weights, being multiples of the sovereign, such as has been proposed, is generally used. They are ordinarily made of brass, and are employed for *determining the number only, not the legal weight of the coins.* It would appear, therefore, that, strictly speaking, the provisions of the new Coinage Bill are not applicable to these coin weights; although it is probable that bankers will gladly avail themselves of the means of having a stamped series of weights duly verified as to their accuracy.

Various weights of single coins.

The other description is that of weights of single coins of various kinds, including many that are unstamped, as well as the weights of a sovereign and half sovereign, which are now verified and stamped at the Mint under the provisions of 14 Geo. 3. c. 92., this duty being now about to be transferred to the Standards Department.

Weighing apparatus for single coins.

But there are also other instruments now commonly used by shopkeepers and others for determining the just weight of gold and silver coins, one of which is an ingenious patent instrument, and has been exhibited by me to the Commission. It is constructed to show the proper size of each coin by means of a gauged opening, and to determine the weight by a balancing lever apparatus adapted to each coin, upon which the coin rests when placed in the gauged opening, if below the proper weight; it falls through, if of the just weight.

It is presumed that any such mechanical apparatus for determining the weight of the gold and silver coin is not intended either to be verified and stamped at the Standards Department, or else prohibited to be used under a penalty of 50*l.* Strictly speaking, the apparatus is not a *weight* such as is described in s. 17, and it would probably be held by a magistrate that the provisions of the Act do not apply to it.

As to inspection of coin weights. Existing powers of inspectors.

As to the inspection of coin weights, which may be stamped in pursuance of the Coinage Act, or used by the public, it is to be observed that s. 21 of the Weights and Measures Act, 5 & 6 Will. 4. c. 63, which defines the powers and duties of Inspectors, limits their duties of stamping to weights "used for buying and selling, or for "the collection of any tolls or duties, or for the making of "any charges on the conveyance of any goods or merchan-"dize;" and s. 28 limits their powers of inspection to shops and places within their respective jurisdictions "wherein goods shall be exposed or kept for sale, or shall "be weighed for conveyance or carriage;" where the Inspectors are "to examine all weights, &c., and to compare "and try the same with copies of the Imperial Standard "weights and measures required or authorized to be pro-"vided under this Act."

Not extending to coin weights.

It is clear, therefore, that these powers of inspection do not extend to the testing of the *justness* of the coin weights authorized under the new Coinage Act.

Nor requir for the protection of the public.

Nor does any such inspection seem to be required. Any person possessing or using such coin weights must require them for his own security against taking light coins, and his interest will impel him to see that they are of just weight. It does not appear how any loss could be sustained by the public from the possession or use by a shopkeeper of defective or unjust coin weights, such as they would suffer from false or defective commercial weights. But under any circumstances full protection against any possible loss is afforded by the heavy penalty imposed by the new Act on the possession or use of any unjust coin weight. It should be particularly noticed that in any such case *any person* can lay an information, whilst under the Weights and Measures Acts Inspectors only can do so.

But heavy liability now proposed on shopkeepers.

So far as the public are concerned, their interests are thus fully protected. But the provisions of the new Act, as affecting the interests of shopkeepers, may require further consideration.

Coin weights made of glass or other material, and not stamped, are, I believe, now very commonly used by shopkeepers to test gold and silver coins. Although Inspectors cannot test the *justness* of coin weights, under s. 28 of 5 & 6 Will. 4. c. 63, by comparison with their copies of the Standards, they are empowered to *examine all weights* in shops or places both to inspection, and a shopkeeper neglecting or refusing to produce for examination, when required, *all weights* in his possession, is liable to a penalty. Now, a sharp Inspector may see at once if a coin weight *is not duly stamped,* as required by s. 17 of the new Coinage Act, and in every such case a shopkeeper would be liable to a penalty not exceeding 50*l.* Can such a heavy penalty be seriously contemplated for so trivial an offence?

The clause in the new Act imposing the penalty of 50*l.*, appears to be taken from s. 5 of 14 Geo. 3. c. 92, but with the important addition that no penalty is there imposed upon the possession or use of an *unstamped* coin weight. The previous clause 4 merely directs that no other than such duly stamped coin weights "shall be reputed or ac-"cepted in law to be true, or of any effect for determining "the weight of the gold or silver coin of the realm."

Suggested alteration.

It may be suggested that a similar enactment in s. 17 of the new Act would more fairly meet the existing requirement, and that the words in line 123 of page 7, "or know-"ingly use any weight declared by the section not to be a "just weight" should be omitted.

Conclusion.

In conclusion it may be mentioned that s. 4 of 14 Geo. 3. c. 93, contains two further provisions relating to penalties,—

1. That half the penalty is to go to the informer.
2. That in default of payment the person convicted may be committed to prison for three months.

These provisions are not included in s. 17 of the new Act, although the second is contained in the Summary Procedure Act, recited in s. 18. But no power is taken to award half the penalty to the informer. Under s. 18 of the Summary Procedure Act the informer may get his costs, but by s. 31 the whole penalty is to go to the Local Funds.

H. W. CHISHOLM,
Warden.

Standards Office,
21st March 1870.

APPENDIX VI.

Paper delivered by the Warden of the Standards.—Reverification of Official Standard Imperial Measures of Capacity; Comparison and Verification of New Imperial Standards of Capacity.

PART I.—Reverification of Official Standard Measures of Capacity.

Contents.

Page

Two modes of comparing standard measures of capacity - 79
  1. By *measurement* of water contained in them - ,,
  Description of this process - ,,
  2. By *weight* of water contained in the measures - ,,
  Shown by Captain Kater, in 1825, to be the more accurate mode - 80
  His description of the process - ,,
Legal definition of standard measures of capacity - ,,
Kater's mode of corrections for variations of temperature - ,,
And of atmospheric pressure - ,,
Later determinations by Regnault and others - ,,
Rate of expansion of air - ,,
Rate of expansion of water - ,,
Professor Miller's tables of expansion of water - ,,
Mean density of brass or bronze - 81
  Table of corrections for temperature - ,,
  Table of corrections for atmospheric pressure - ,,
Official standards of capacity originally verified by weighing their contents of water - ,,
This mode now adopted for their reverification - ,,
Description of the official standard measures of capacity - ,,
Table of their denominations, dimensions, &c. - 82
Description of the four original standards of capacity - ,,
  Imperial standard bushel - ,,
  Imperial standard gallon, of conical shape - ,,
  Standard quart and pint - ,,
Duplicate standards of gallon, quart, and pint - ,,
Reverification of official standards first proceeded with - ,,
Reconstruction of Kater's large balance - ,,
Necessity of distilling water in the office - ,,
Mode of comparing the standard measures - ,,
Actual comparison of the official standards - 83
Corrections for temperature and pressure - 84
Results of these comparisons - ,,
Table of equivalents of grain weights of distilled water and capacity in cubic inches - ,,
Results of comparisons reported to Standards Commission - ,,
And notified to manufacturers of standard measures - ,,

Page

Capacity of official standards as ascertained by linear measurements - 84
Including computation by Kupffer's determination - ,,
Table of capacity and errors of official standards from linear measurements - 85
Approximate measurement by Astronomer Royal's gauging rod - ,,
Readjustment of the larger official standard measures of capacity and half gill - ,,
Their reverification - ,,
Their actual comparisons, and the results - 86
Proceedings for reverifying the imperial standard bushel and conical measures - ,,
Discordant results of weighing the bushel with distilled water - ,,
Table of these results - ,,
Probable causes of the discordances of weight of water - 87
Flexure of large glass disc - ,,
Experiment of weighing half bushel measure with bushel disc - ,,
Weighings of the two standard bushels with thick disc - ,,
New thick glass disc for bushel measure - ,,
Unsatisfactory results of these weighings - ,,
Change in the order of weighing - 88
New method of weighing the imperial standard bushel - ,,
Actual comparison of imperial standard bushel with thick glass disc - ,,
Results of these comparisons - ,,
Professor Miller's suggestion of levelling the water in the bushel - ,,
As to the form of standard best suited for dry and liquid measures - 89
Reverification of conical standard measures of capacity - ,,
Mode of filling them with distilled water - ,,
Actual comparisons of these conical standard measures - 90
Mean results - 91
Account of new standard measures and their verification to be given in a subsequent paper - ,,

Two modes of comparing standard measures of capacity.

There are two modes of comparing standard measures of capacity of the same denomination with each other, and ascertaining their actual contents. Both are fully described in the "Directions for using the Standard Weights and "Measures," drawn up by Captain Kater in 1825, and officially transmitted by the Treasury to the Exchequer for the guidance and assistance of the officers of the Department. A copy of these directions is appended to Mr. Chisholm's report on the Exchequer Standards, dated 27th April 1863 (App. 2, p. 45.). These two modes are as follows:—

1. By measurement of water contained in them.

1. By *measuring* the quantity of water contained in each standard when quite full to the brim and accurately levelled, at equal temperatures.

This mode has always been adopted in the Department for verifying copies of the official standard measures of capacity. Though a less precise method of comparison, it has been deemed sufficient for all practical purposes, and, in accordance with Captain Kater's instructions, no allowance for temperature or atmospheric pressure has ever been required or made.

Description of this process.

The actual process of comparison ordinarily employed in the Standards Department may be thus described.

The standard and the measure to be compared are left together in the same room, with the water to be used, for 24 hours previous to the comparison, in order to equalize their temperature as far as possible. The water used is that supplied from the artesian well in Trafalgar Square, to the cistern in the comparing room.

The process begins by accurately levelling the standard measure, which is then slowly filled with water by means of a syphon of small bore, until the water appears slightly elevated above the rim of the vessel. Care is taken to remove, by means of a quill, any bubbles of air that may be seen in the water adhering to the sides or bottom of the measure. A circular piece of plate glass with a plane surface and a small hole in the centre in a depressed cup is then gently slid along the rim, any superfluous water being thus slowly thrown off, and any which may have passed through the small hole into the cup being removed by a small suction tube having a bulb, and termed a *pipette.* If a few drops are wanting to fill the measure they are added by means of the same tube.

The measure to be compared having been also accurately levelled, is then filled with water, emptied, and drained; and the water from the standard is transferred to it by means of the syphon. This transfer is completed by holding the standard inverted over the measure to allow as much as possible of the water to drain into it.

A similar preliminary process of filling with water, and draining is gone through with the syphon as with the compared measure, in order to avoid as far as possible the loss of any film of water that may be left either in the standard measure or the syphon, after the transfer of the water to the compared measure.

The glass plane with any water that may be left upon it is now slid over the measure. Any deficiency in the capacity is ascertained by measuring the quantity of superfluous water, and any excess in its capacity by measuring the quantity of water required to fill it. This measure of error is found by a graduated glass or *burette,* showing parts of a fluid ounce, as well as of a cubic inch.

2. By weight of water contained in

2. By accurately weighing the quantity of distilled water similarly contained in each standard measure, making the

Appendix VI.—*continued.*

the measures.

necessary corrections for the temperature of the water and and for atmospheric pressure.

Shown by Captain Kater, in 1825, to be the more accurate mode.

This second mode is considered to be by far the most accurate, and its adoption in all cases was strongly urged by Captain Kater. With reference to it Captain Kater stated:—

"It must, however, be recollected that the spirit of the Act for 'ascertaining and establishing uniformity of Weights and Measures,' as well as one of the most important advantages it presents, consists in the definition of the measure of capacity, by the weight of distilled water which it shall contain. This is by far the most accurate, and will perhaps be found in practice to be the most ready method of determining such measures.

His description of the process.

"For this purpose the measure to be examined is to be placed in one of the pans of the balance, together with the weight of the water which it is to contain, and also a piece of plane glass of a size sufficient to cover it having a small orifice in the centre, and the whole is to be counterpoised with brass. The weight is then to be removed and the vessel filled with water, carefully detaching air bubbles, should any be formed. The temperature of the water and the height of the barometer are then to be taken, and the number of grains due to such temperature and pressure found in the annexed tables is to be added to the counterpoise or placed in the other scale according as the sign is + or —. The glass is then to be slid upon the top of the vessel, adding a little water if necessary through the small aperture. If the capacity of the vessel is correct, the whole will now be in equilibrium."

Legal definition of standard measures of capacity.

The standard measures of capacity were originally constructed and verified to contain the requisite "weight of "distilled water, weighed in air at the temperature of 62° "Fahr., the barometer being at 30 inches;" such is their legal capacity as described in s. 6 of the Act of 1825, 5 Geo. 4. c. 74.

Kater's mode of corrections for variations of temperature.

Kater's account, p. 32.

Corrections for all other temperatures than 62° Fahr. were stated by Capt. Kater in his "Account of the new "Standards of Weights and Measures" (Phil. Trans. 1826), to be requisite to allow for the difference between the expansion of water and of the metallic vessel in which it is contained; and his table of corrections is appended to this paper. It may be seen that an error of 1° Fahr. in the determination of the temperature of the water contained in the gallon between 62° and 70° would occasion an error ranging from 4 to 6 grains, and consequently in the bushel from 32 to 48 grains; the noting of the exact temperature of the water is therefore of primary importance.

Captain Kater does not state the mode of construction of his table of corrections for temperature, nor the data on which these corrections were based. He merely says, "The difference of the expansion of water and of brass "being an object of the highest importance in the present "operation, I was glad to find that Mr. Bate had made "numerous experiments upon the subject, and I had "sufficient experience of his care to place great reliance on "his conclusions." He considered that the considerable range of temperature under which the experiments of verifying the standard measures were made, and the uniformity of the results fully justified this confidence and formed very conclusive evidence of the accuracy of the corrections employed.

and of atmospheric pressure.

In order to obtain due accuracy, a further correction is required for the pressure of the atmosphere. Kater based his corrections upon the assumption that water is 831 times heavier than air when the barometer is at 30 inches and the thermometer at 62° Fahr., and that this rate varied directly as the height of the barometer (that is to say, assuming the temperature to be unaltered); consequently the correction due to a difference of 1 inch of the barometer would be $\frac{1}{831} \times \frac{1}{30} = \frac{1}{24930}$ part of the weight of water.

The weight of water being counterpoised with brass, and this metal being taken by Kater to be about eight times heavier than water, the effect of the buoyancy of the atmosphere upon the metals would be only $\frac{1}{8}$ of that upon water, thus tending to lessen the effect upon the water by about $\frac{1}{8}$ part of the whole quantity. It would follow that $\frac{1}{24930} \times \frac{7}{8} \times 70000$ grains $= 2{\cdot}46$ grains, would be the number of grains by which the weight of a gallon of water must be increased by a depression of one inch of the barometer. Although the variation of the temperature of the air during the experiments might be several degrees, the effect upon the correction for the buoyancy of the atmosphere would be so inconsiderable as not to require notice.

Later determinations by Regnault and others.

Since Kater's time further experiments upon the relative weight of air and water under various temperatures and pressures of the atmosphere have been made by other men of science, and particularly by M. Regnault, whose results have since been generally accepted as authoritative in all countries of Europe.

Graham's Element Chemistr

According to the new and most careful determination of the weight of air by M. Regnault, 100 cubic inches of atmospheric air, deprived of aqueous vapour and the small quantity of carbonic acid it usually contains, weigh 30·82926 grains at 60° Fahr., and barometer 30 in. Its density at the same temperature and pressure is estimated at 1,000, and is conveniently assumed as the standard of comparison for the densities of gaseous bodies, as water is for solids and liquids. Hence at 62° air is 810 times lighter than water.

Rate of pansion air.

The rate of expansion of air and gases from increase of temperature was long involved in considerable uncertainty, from the neglect of experimenters to dry the air or gas on which they operated. The more recent researches of Magnus and of Regnault give as the expansion of a constant volume of dry air from 32° to 212°, $\frac{366{\cdot}5}{1000}$ or $\frac{11}{30}$ of its volume at 32°. The dilatation of a constant volume of air for every degree of Fahrenheit, according to Regnault, is 0·002036, or $\frac{1}{491{\cdot}2}$ part. A table of the expansion by heat of a volume of air *under constant pressure*, from 50° to 90° Fahr., is shown in App. 8, the coefficient of such expansion being 0·0020392.

Rate of pansion water. Ib., p. 8

With respect to the rate of expansion of water, no progress appears to have yet been made in discovering the law by which expansions of liquids are regulated. Two laws have been laid down; the first, that some liquids expand much more considerably by heat than others; the second, that liquids are progressively more expansible at higher than at lower temperatures.

The expansion of water by heat is subject to a remarkable peculiarity, which makes this liquid at a certain range of temperature become an exception to the very general law that bodies expand by heat. From 32° Fahr., when water becomes ice, *instead of expanding it contracts with every addition of heat up to about 39°, above which temperature it expands in the same ratio as it contracts below.*

Miller, p. 790.

The rate of expansion of water under ordinary temperatures of the atmosphere has been considered by Professor Miller to have been authoritatively determined by the mean results of the experiments made by Despretz, Pierre, and Kopp, who employed the same method of experimenting, with thermometer tubes filled with water. The expansion of the glass used was inferred from the apparent expansion of the mercury in the thermometer from 0° to 28°, using for the coefficient of expansion of mercury 0·00018018, the value obtained by Dulong and Petit. Professor Miller has applied some slight corrections to the stated results of these observations by preferring to take the mean coefficient of the expansion of mercury at 0·00017971, and of glass free from lead at 0·00002688 for 1° C., from 0° to 28°, as determined by Regnault.

Assuming 3°·945 C. (39°·1 Fahr.) to be the temperature at which the density of water is at a maximum, in accordance with the results obtained by Playfair and Joule, the rate of expansion of water is shown by Professor Miller to be as follows:—

Profess Miller's table o pansio water.

t. Centigrade.	Ratio of the maximum Density of Water to its Density at *t*°.	Rate of Expansion for 1° C.
3·945	1·000000	—
5	1·000008	—
6	1·000031	0·000023
7	1·000069	0·000038
8	1·000121	0·000052
9	1·000186	0·000065
10	1·000265	0·000079
11	1·000357	0·000092
12	1·000460	0·000103
13	1·000581	0·000121
14	1·000712	0·000131
15	1·000854	0·000142
16	1·001009	0·000155
17	1·001175	0·000166
18	1·001352	0·000177
19	1·001540	0·000188
20	1·001739	0·000199
21	1·001948	0·000209
22	1·002167	0·000219
23	1·002396	0·000229
24	1·002634	0·000238
25	1·002882	0·000248

Appendix VI.—*continued.*

The mean rate of expansion between 3°·945 and 25° is thus shown to be 0·000137 for 1° C., or 0·000076 for 1° Fahr.

Mean density of brass or bronze. Miller, p. 805.

The mean specific gravity of brass or bronze weights has been proved by Professor Miller somewhat greater than that assumed by Captain Kater, and to be about 8·150.

Corrections for temperature and atmospheric pressure.

Captain Kater's corrections for temperature and atmospheric pressure are shown in the following table, which also shows the more recently determined corrections deduced from Regnault's observations, by Professor Miller, and furnished by him on 1st November 1867 for the use of the Standards Department:—

Table of corrections.

Corrections for Temperature on the Gallon.

Temperature of the Water.	Captain Kater's Table, in 1825.		—	Professor Miller's Table, in 1867.	
	Correction in Grains.	Difference for One Degree.		Correction in Grains.	Difference for One Degree.
Fahrenheit.			Fahrenheit.		
50°	+35·45	—	50°	+33·96	—
51°	+33·97	+1·48	51°	+32·63	+1·33
52°	+32·21	+1·76	52°	+31·02	+1·61
53°	+30·18	+2·03	53°	+29·12	+1·90
54°	+27·88	+2·30	54°	+26·95	+2·17
55°	+25·30	+2·58	55°	+24·51	+2·44
56°	+22·46	+2·84	56°	+21·79	+2·72
57°	+19·36	+3·10	57°	+18·80	+2·99
58°	+16·00	+3·36	58°	+15·54	+3·26
59°	+12·38	+3·62	59°	+12·03	+3·51
60°	+ 8·50	+3·88	60°	+ 8·27	+3·76
61°	+ 4·38	+4·12	61°	+ 4·26	+4·01
62°	0·00	+4·38	62°	0·00	+4·26
63°	— 4·62	—4·62	63°	— 4·50	—4·50
64°	— 9·49	—4·87	64°	— 9·24	—4·74
65°	—14·60	—5·11	65°	—14·21	—4·97
66°	—19·94	—5·34	66°	—19·42	—5·21
67°	—25·52	—5·58	67°	—24·87	—5·45
68°	—31·33	—5·81	68°	—30·55	—5·68
69°	—37·38	—6·05	69°	—36·44	—5·90
70°	—43·65	—6·27	70°	—42·56	—6·12

Corrections for the Barometer.

Barometer.	Correction in Grains.	
	Captain Kater, in 1825.	Professor Miller, in 1867.
29·0 inches	+2·50	+2·51
29·1 „	+2·21	+2·26
29·2 „	+1·97	+2·01
29·3 „	+1·72	+1·76
29·4 „	+1·48	+1·51
29·5 „	+1·20	+1·26
29·6 „	+0·98	+1·00
29·7 „	+0·74	+0·75
29·8 „	+0·49	+0·50
29·9 „	+0·25	+0·25
30·0 „	0·00	0·00
30·1 „	— 0·25	— 0·25
30·2 „	— 0·49	— 0·50
30·3 „	— 0·74	— 0·75
30·4 „	— 0·98	— 1·00
30·5 „	— 1·20	— 1·26
30·6 „	— 1·48	— 1·51
30·7 „	— 1·72	— 1·76
30·8 „	— 1·97	— 2·01
30·9 „	— 2·21	— 2·26
31·0 „	— 2·50	— 2·51

Below 62° the water in the gallon vessel appears to be heavier than the 10 lb. weight, consequently the number of grains corresponding to the temperature with the sign + must be added to the 10 lbs. When the sign is —, the number of grains indicated by the temperature must be added to the water.

The same mode of correction is applicable to the barometric pressure.

fficial tandards of apacity riginally erified by veighing heir contents of water.

When the original standards of capacity were constructed in 1825, under Captain Kater's superintendence, he adopted the mode of verifying them by the weight of water contained in each standard measure. In his published "Account of the new Standard of Weights and Measures" (p. 31, &c), he describes the process of verification and the results of the numerous comparisons made, as well as the principles upon which he formed his tables of correction.

This mode now adopted for their reverification.

The same mode has now therefore been adopted for the reverification of the official standards of capacity, and their comparison with each other. The only variations that have been made from Captain Kater's method have been to use the more recently determined tables of corrections and to counterpoise with *gun metal*, instead of *brass*; all the official standards of capacity being made of gun metal, the weights used for their comparison are thus of similar metal and density.

Description of the official standard measures of capacity.

The official standard measures of capacity which have been used in the department since 1834, for the comparison and verification of the local standards for inspectors of weights and measures, were made by Mr. Bate, to whom the construction of the original standard measures of capacity was entrusted by Captain Kater in 1824. These official standards were furnished to the Exchequer in 1834, under Treasury authority, and were substituted for a temporary set previously supplied by Mr. Bate, which had been certified by Captain Kater as fit and accurate standards. Before the temporary standards were returned to Mr. Bate, the new standards were carefully compared and verified with them by the Exchequer officers. But no further authoritative verification of these official standard measures appears to have been made, nor either set to have been in any way compared with the original standards constructed under Captain Kater's directions, and verified by him in 1824. It would seem that they were taken as accurate, from the trust deservedly placed in Mr. Bate.

Kater's account, p. 9.

These official standard measures are believed to be of the same metal as the original standard measures, viz., gun metal, composed of a mixture of 576 parts of copper, 59 of tin, and 48 of brass, as approved by Captain Kater. They are cylindrical in shape, being cast in one piece, and finished by turning. Their internal form is a true cylinder, and the periphery of the bushel is half an inch in thickness for about one inch from the top and two inches from the bottom, to the latter two handles being attached, with a piece of turned ivory to lay hold of. The middle part of the cylinder is half the thickness of the other part. The smaller measures are similarly made, the thickness of the metal and the depth of the rims being proportionally less. The gill and half gill measures have no handles, but are protected by ivory rings screwed to the lower rims. The metal of these standard measures of capacity is thus never touched with the hand, and after being used and the water emptied, they are carefully dried with a cloth, and rubbed with clean and dry wash leather. The surface of each of them is now in excellent condition, being bronzed with a natural oxide, and highly polished, so that hardly any water remains upon it.

Appendix VI.—*continued.*

Table of their denominations, dimensions, &c.

The following table shows the number of the official standard measures of capacity, the approximate measures of their internal diameter and height, the standard weight of their contents of distilled water, and their legal capacity in cubic inches, laid down in s. 5., of the Act 5 Geo. 4. c. 74., and based upon Sir George Shuckburgh's determination of the weight of a cubic inch of water=252·458 grains, made in 1798, and confirmed by Capt. Kater in 1821:—

Standard Measure.	Approximate Internal Diameter, in Inches.	Approximate Internal Height, in Inches.	Standard Weight of Contents of distilled Water, at 62° Fahr., Barometer 30 inches.		Legal capacity in Cubic Inches.
			In lbs. Avoirdupois.	In Grains.	
Bushel - - -	$18\frac{1}{2}$	$8\frac{1}{4}$	80	560,000	2218·191
Half bushel - -	$14\frac{2}{3}$	$6\frac{1}{2}$	40	280,000	1109·096
Peck - - - -	$11\frac{11}{16}$	$5\frac{10}{64}$	20	140,000	554·548
Gallon - - -	$17\frac{4}{64}$	$7\frac{1}{64}$	10	70,000	277·274
Half gallon - - -	$5\frac{41}{64}$	$5\frac{38}{64}$	5	35,000	138·637
Quart - - - -	$4\frac{30}{64}$	$4\frac{27}{64}$	2·5	17,500	69·318
Pint - - - -	$3\frac{1}{2}$	$3\frac{1}{2}$	1·25	8,750	34·659
Half pint - - -	$2\frac{51}{64}$	$2\frac{50}{64}$	0·625	4,375	17·329
Gill - - - -	$2\frac{14}{64}$	$2\frac{13}{64}$	0·3125	2,187·5	8·664
Half gill - - -	$1\frac{50}{64}$	$1\frac{47}{64}$	0·15625	1,093·75	4·332

It will be seen that whilst the three larger measures have the diameter nearly double the height, the seven smaller measures have the diameter nearly equal to the height.

Description of the four original standards of capacity.

There are only four original standard measures of capacity, which were constructed in 1824 and verified by Captain Kater, viz.:—

The imperial standard bushel.
" gallon.
" quart.
" pint.

Imperial standard bushel.

The standard bushel is cylindrical, corresponding in its internal dimensions with the official standard bushel. But it has no handles attached to it, these being attached to the mahogany stand constructed for it. It is much heavier and more strongly constructed than the official standard. It was cast in two pieces, consisting of a cylinder ½ inch thick with two projecting hoops ½ inch deep and 1 inch wide, one half an inch below the upper rim, the other in a line with the lower rim. The bottom was cast separately. It is strengthened with eight radial bars, and is screwed to the lower projecting hoop. Four such standard bushels were constructed in 1824, and verified by Capt. Kater, the process being described in his Account in the Construction of the new Standards. The imperial standard is No. 3, its mean error in grains weight of water is stated as +6·47 grains. The other three standards were sent to the three metropolitan cities.

It may be convenient to observe that this primary standard bushel is distinguished as the "Imperial standard bushel," whilst the official copy is called the "Official standard bushel."

Imperial standard gallon, of conical shape.

The three smaller standards are of a different shape. They are conical, the mouth being cylindrical; that of the standard gallon is 1½ inch in diameter, the top being ground perfectly flat and the edge rounded off, so that the contents may be poured from it into another vessel without running down the side. The cone is placed in a cylinder about 4 inches high, with handles; this serves both to protect the gallon from injury and to prevent any change of temperature from handling. The standard quart and pint are of similar form on a smaller scale.

Standard quart and pint.

These three conical standards are the primary standards of those denominations, and bear the inscription, "Verified by Captain Henry Kater, F.R.S., Bate, London." They were amongst the standards which remained at the Treasury until 1865, when they were transmitted to the Standards Office. The Imperial standard gallon, called No. 3 by Captain Kater, was found by him to have a mean error of +0·14 grain weight of water; the quart to be—0·05 grain, and the pint +0·09 grain.

Duplicates of gallon, quart, and pint.

Three duplicates of these conical standards were deposited by Captain Kater at the Exchequer in 1825. They are precisely similar in appearance to the standards, with the exception of not bearing the inscription, verified by Captain H. Kater. The gallon is No. 2 of the series verified by Captain Kater. He has given no account of the verification of the three standard measures. These three duplicate conical measures, which were probably intended as working Departmental Standards, will be distinguished as No. 2, the three primary standard measures of reference being No. 1.

Reverification of official standards first proceeded with.

As it was of importance that the accuracy of the official standard measures of capacity used for comparing local standards should be determined as soon as possible, their reverification was first proceeded with.

Reconstruction of Kater's large balance.

The weighings of the three larger standard measures of capacity, the imperial bushel, half bushel, and peck, with their contents of distilled water, have been made with the large balance, which was originally constructed by Mr. Bate under Captain Kater's direction for the verification of the imperial standard bushel in 1824, and has been recently reconstructed by Mr. Oertling with all the more modern improvements. The mahogany beams and the two scales and pans alone remain alone of the original balance, which was intended to carry the weight of 300 lbs. in each pan. The balance is now enclosed in a large plate glass case.

Necessity of distilling water in the office.

Considerable delay has unavoidably occurred in the reverification of the official standard measures of capacity, not only from the lapse of time occupied in the reconstruction of Kater's large balance, but also from the discordances found in the weighings on successive days of the standard bushel filled with distilled water purchased for the purpose. In order to obtain distilled water as pure as possible, it was considered necessary to distil it in the office, so that it might be pure and fresh for use from time to time. A still with a large cistern and all the necessary appliances, made where requisite of pure tin, has therefore been constructed for the Department by Messrs. Tylor.

Mode of comparing the standard measures.

It was not until after the completion of all these preliminary arrangements that the definite comparisons of the official standard measures of capacity could be satisfactorily effected. The mode of comparison adopted was that directed by Captain Kater, viz., by placing each of the standard measures and its glass disc, together with the requisite standard weights forming the nearest equivalent of the legal weight of the water to be contained in the measure at the standard temperature and atmospheric pressure, in the right-hand scale of the large balance; this scale having been specially constructed for this purpose. These were counterpoised with gun-metal weights placed in the left-hand scale. The standard weights being then removed from the right-hand scale, the standard measure, when in the scale, was filled with distilled water and covered with its disc. Additional balance weights were added either to the right-hand or the left-hand scale, equivalent to the requisite corrections for the exact temperature and atmospheric pressure, together with the error in the standard weight of the water contained in the measure, until an equilibrium was obtained.

Appendix VI.—*continued.*

The standard weights used in the several comparisons, and the results of the weighings, are shown in the following Table:—

Actual comparison of the official standards.

Comparisons of Official Standard Measures of Capacity.

Comparisons (1) to (6) were taken with Kater's large balance.
„ (7) „ (10) „ Oertling's balance No. 1.
„ (11) „ (16) „ „ No. 2.
„ (17) „ (20) „ „ No. 3.

Note.—Six weighings were taken for each comparison, by the method of counterpoise. When the balance grain weights were added to the comparing standard weights, it will be seen that in the following table, they are shown as deducted from the weight of the compared standard measure. The grain weights used were the official set No. 1, except where the gilt grains are specified.

No.	Date of Comparison.		Weight of Water contained in compared Standard Measure, &c.	Comparing Standard Weights.	Difference in Divisions.	Value of one Div. of Balance.	Difference in Grains.
	1869.				d.	gr.	gr.
(1)	Sept.	7	Bushel + bullion 0·4 0·1, 0·04, 0·03, 0·2, 0·005, oz. (or 285·32746 gr.)	≏ Bullion 500, 400, 200, 50, 10, 5 1, 0·5, 0·1, 0·05, 0·02 oz. (or 559999·82591 gr.)	+ 0·650	0·39200	+0·25480
(2)	Oct.	26	Bushel − 0·2 oz. (or 95·99960 gr.)	≏ Pyx troy 360 oz. to 12 oz. - } =518387·50498 gr. Gilt lbs. Nos. 31 to 34 - - } =27999·98262 „ Bullion 20, 5, 2, 1, 0·3, 0·02, 0·04 oz. } =13612·77243 „ Total - 560000·26003 „	− 1·000	0·34129	−0·34129
(3)	„	16	Half bushel + bullion 0·2, 0·01, 0·005 oz. (or 103·19705 gr.)	≏ Bullion 500, 50, 30, 3, 0·2, 0·05, 0·04, 0·03, 0·01, 0·005 oz. (or 279999·74686 gr.)	− 3·125	0·37000	−1·15625
(4)	„	18	Half bushel − 20, 3 gr. (or 23·00037 gr.)	≏ Bullion 500, 50, 30, 3, 0·3, 00·3, 0·005 oz. (or 27999·75612 gr.)	+ 2·500	0·40415	+1·01037
(5)	Sept.	10	Peck + 100 gr. (or 100·00094 gr.)	≏ 10 lbs. K. + 10 lbs. O. (or 140001·31653 gr.)	+ 1·500	0·55800	+0·83700
(6)	Oct.	19	Peck − 20, 3, 2 gr. (or 25·00032 gr.)	≏ Ditto - - - -	− 2·750	0·61538	−1·69230
(7)	Sept.	23	Gallon + 2 gr. (or 1·99995 gr.)	≏ 10 lbs. O. (or 7001·06681 gr.) -	− 2·425	0·40810	−0·98964
(8)	Oct.	18	Gallon − 20 gr. (or 20·00004 gr.)	≏ 10 lbs. K. (or 70000·29200 gr.) -	− 2·875	0·25157	−0·72326
(9)	„	19	Halfgallon − 6, 3, gr. (or 9·00013 gr.)	≏ Gilt lbs. Nos. 31, 32, 33, 34, and grain standards 4000, 2000, and 1000 B. (or 34999·99187 gr.).	− 7·325	0·17737	−1·29923
(10)	„	25	Half gallon − 6 gr. (or 5·99980 gr.)	≏ Bullion 50, 20, 2, 0·5, 0·4, 0·02, oz. (or 35001·55046 gr.)	− 1·775	0·42189	−0·74885
(11)	Sept.	23	Quart + 1 gr. (or 1·00002 gr.)	≏ Bullion 30, 5, 1, 0·4, 00·5, 00·1, oz. (or 17500·77131 gr.)	−10·225	0·12500	−1·27812
(12)	Oct.	25	Quart − 3 gr. (or 3·00033 gr.)	≏ Gilt lbs. 31, 33, and standard 2000, 1000 B., and 500 gr. (or 17499·99554).	+ 9·950	0·10000	+0·99500
(13)	„	20	Pint − 3, 1 gr. (or 4·00035 gr.)	≏ Gilt lb. No. 31, and 1000, 600, 100, 30, 20 gr. (or 8749·99533 gr.)	− 4·825	0·08332	−0·40197
(14)	„	26	Pint — 2, 0·6 gr. (or 2·59978 gr.)	≏ Ditto - - - -	+ 6·050	0·05754	+0·34812
(15)	„	27	Half pint − 1, 0·3 gr. (or 1·29977 gr.)	≏ 4000, 300, 60, 10, 3, 2 gr. (or 4375·01409 gr.)	+12·700	0·03699	+0·46977
(16)	„	28	Half pint − 0·6 gr. (or 0·59983 gr.)	≏ Ditto - - - -	− 4·975	0·02992	−0·14885
(17)	„	25	Gill + gilt grains 0·3, 0·2 (or 0·49930 gr.)	≏ Bronze grain standards T. R. + gilt grains 100, 60, 20, 6, 1, 0·3, 0·2, (or 2187·50259 gr.)	−24·125	0·00120	−0·02895
(18)	„	27	Gill + gilt grains 600, 300 − gilt grains 0·6, 0·06, 0·1 (or 899·24226 gr.)	≏ Gilt grains 2000, 1000, B. 60, 20, 6, 1, 0·3, 0·2 gr. (or 3087·50633 gr.)	−21·000	0·00400	−0·08413
(19)	„	„	Half gill - -	≏ Gilt grains 1000, B. 60, 30, 3, 0·6, 0·1, 0·06 (or 1093·76093 gr.)	+ 9·000	0·00203	+0·01827
(20)	„	28	Half gill + gilt grains 0·3, 0·06 (or 0·36029 gr.)	≏ Ditto - - - -	−20·000	0·00312	−0·06240

Appendix VI.—*continued.*

CORRECTIONS of COMPARISONS of OFFICIAL STANDARD MEASURES of CAPACITY.

Corrections for temperature and pressure.

No.	Standard compared.	Weight of Water contained in the Standard.	Barometer.	Temperature.	Correction for Pressure and Temperature.	Weight of Water contained in the Standard, t. = 62° F. b. = 30 in.	Error of Standard in Grains.	Mean Error in Grains.
		Gr.	In.	° Fahr.	Gr.	Gr.		
(1)	Bushel -	559714·49851	29·875	67·245	+207·59280	559922·09131	−77·90869	−83·34557
(2)		560095·91834	29·949	55·570	−184·69680	559911·22154	−88·77846	
(3)	Half bushel	279895·39356	29·313	65·270	+ 55·51680	279950·91036	−49·08964	−47·38519
(4)		280023·76686	29·360	57·935	− 69·44760	279954·31926	−45·68074	
(5)	Peck -	139902·15259	29·351	69·100	+ 70·83700	139972·98959	−27·01041	−25·49213
(6)		140024·62455	29·574	55·470	− 48·59840	139976·02615	−23·97385	
(7)	Gallon -	69998·07722	30·182	61·470	+ 1·80300	69999·88022	− 0·11978	+ 0·20530
(8)		70019·46878	29·418	57·410	− 18·93840	70000·53038	+ 0·53038	
(9)	Half gallon	35007·69907	29·650	54·960	− 12·74130	34994·95777	− 5·04223	−5·51188
(10)		35006·80141	30·173	54·390	− 12·78295	34994·01846	− 5·98154	
(11)	Quart -	17500·77131	30·182	61·550	− 2·64389	17498·12742	− 1·87258	−1·80264
(12)		17503·99087	30·173	55·435	− 5·72358	17498·26729	− 1·73271	
(13)	Pint -	8753·59371	30·194	51·435	− 3·93059	8749·66312	− 0·33688	−0·46306
(14)		8752·94323	29·897	53·515	− 3·53248	8749·41075	− 0·58925	
(15)	Half pint	4376·78363	29·788	52·990	− 1·85431	4374·92932	− 0·07068	−0·00129
(16)		4375·46507	29·558	60·755	− 0·39697	4375·06810	+ 0·06810	
(17)	Gill -	2187·97294	30·184	55·290	− 0·72691	2187·24603	− 0·25397	−0·22121
(18)		2188·17994	29·760	53·890	− 0·86840	2187·31154	− 0·18846	
(19)	Half gill	1093·77920	29·756	53·710	− 0·44043	1093·33877	− 0·41123	−0·44259
(20)		1093·33832	29·769	61·200	− 0·06227	1093·27605	− 0·47395	

RESULTS of COMPARISONS.

Results of comparisons.

Official Standard.	Standard Weight of contents of Distilled Water.	Error in Weight.	Error in Capacity.
	Gr.	Gr.	Cubic in.
Bushel - - -	=559916·656	−83·344	−0·330
Half bushel - -	=279952·615	−47·385	−0·187
Peck - - -	=139974·508	−25·492	−0·101
Gallon - - -	= 70000·205	+ 0·205	+0·001
Half Gallon - -	= 34994·488	− 5·512	−0·022
Quart - - -	= 17498·197	− 1·803	−0·007
Pint - - -	= 8749·537	− 0·463	−0·002
Half pint - - -	= 4374·999	− 0·001	−0·000
Gill - - -	= 2187·270	− 0·221	−0·001
Half Gill - - -	= 1093·308	− 0·442	−0·002

Table of equivalents of grains weight of water, and capacity in cubic inches.

The errors thus stated in parts of a cubic inch are computed from the legal weight of a cubic inch of distilled water, = 252·458 grains, and the following table has been found convenient for this purpose :—

Grains weight of distilled water.	Cubic inch.
1	= 0·003961057
2	= 0·007922114
3	= 0·011883171
4	= 0·015844228
5	= 0·019805285
6	= 0·023766342
7	= 0·027727399
8	= 0·031688456
9	= 0·035649513
10	= 0·03961057
100	= 0·3961057
1000	= 3·961057

Results of comparison reported to the Commission.

The results of the comparisons of the official standard measures of capacity were reported to the Commission at the meeting of 3rd December 1869, and it was agreed by the Commission that the measures of a gallon and under might be deemed practically correct for official comparisons, the ascertained errors being so small as not to affect sensibly the accuracy of the copies compared with them.

and notific by circular to manufacturers o standard measures.

In fact, the errors of all the official standard measures of capacity, including the bushel, were thus found to be considerably within the amount of tolerance provisionally sanctioned by the Commission; but it was considered desirable that the measures of a bushel, half bushel, and peck should be sent to Messrs. De Grave & Co. for readjustment, and more particularly as regards the planes of their rims. With the approval of the Commission, a printed circular, dated 8th December 1869, was issued to the several manufacturers of standard weights and measures in order to inform them of the results of the official reverification of all the official standard measures of capacity.

Capacity of standards as ascertained by linear measurement.

In the meantime it was deemed expedient to compare the errors in parts of a cubic inch of the several official measures of capacity, thus computed from the determined error in grains weight of their contents of distilled water, with their errors in capacity, computed by the difference between their capacity found from direct linear measurement, so far as it can be effected, and their legal capacity, according to s. 5. of the Act 5 Geo. 4. c. 74., derived from Sir George Shuckburgh's determination.

Including computati by Kupffer determination.

As however this determination does not agree with the more recent, and perhaps more accurate, determination by Kupffer in 1841, viz., 252·334 grains, as shown in Appendix V.–1. to the Second Report of the Commission, it may be more satisfactory also to include in the comparison the capacity in cubic inches of the several measures according to Kupffer's determination. The difference of 0·124 grain between the two determinations of the weight of a cubic inch of water, would amount to more than 275 grains, or 1·089 cubic inch, in the capacity of a bushel to contain 2218·191 cubic inches.

Appendix VI.—*continued.*

TABLE of CAPACITY and ERRORS of OFFICIAL STANDARDS from Linear Measurement.

Official Standard Measure.	Capacity.			Errors by linear measurement.	
	By linear measurement.	As determined by 5 Geo. 4. c. 74.	By Kupffer's determination.	As compared with legal capacity, 5 Geo. 4. c. 74.	As compared with Kupffer's determination.
	cub. in.	cub. in.	cub. in.	cub. in.	cub. in.
Bushel - -	2217·626	2218·191	2219·280	−0·565	−1·634
Half-bushel - -	1110·680	1109·096	1109·640	+1·584	+1·040
Peck -	553·163	554·548	554·820	−1·385	−1·657
Gallon - -	274·836	277·274	277·410	−2·438	−2·574
Half-gallon - -	139·750	138·637	138·705	+1·113	+1·045
Quart - -	69·354	69·318	69·352	+0·036	+0·002
Pint - - -	33·674	34·659	34·676	−0·985	−1·002
Half-pint - -	17·087	17·329	17·338	−0·242	−0·251
Gill - - -	8·518	8·664	8·669	−0·146	−0·151
Half-gill - -	4·322	4·332	4·335	−0·010	−0·013

The statement of the capacity by linear measurement is computed from the approximate internal diameter and height previously shown by multiplying the square of the diameter by 0·7854 (the proportionate area of a circle), and the product by the height. This measurement was made with as much accuracy as the existing instruments in the Standards Department would allow. A new measuring gauge is now being constructed by Messrs. Troughton and Simms, in order that all such measuremeuts may be made with the utmost possible precision.

Approximate measurement by Astronomer Royal's gauging rod.

It may also be interesting to show the result of measuring each of the official standard measures of capacity with the gauging rod constructed as a means of approximate measurement under the Astronomer Royal's directions for the use of Inspectors of Weights and Measures.

CONTENTS of OFFICIAL STANDARD MEASURES of CAPACITY, as ascertained approximately by GAUGING ROD.

Official Standards.	Measurement by Gauging Rods.			Figure on rod representing exact Standard.	Difference of Official Standards.
	Depth.	Diameter.	Sum.		
Bushel - -	28	70¾	98¾	100	−1¼
Half-bushel - -	24½	65¼	89¾	90	− ¼
Peck - -	21¼	58½	79¾	80	− ¼
Gallon -	25¾	44	69¾	70	− ¼
Half-gallon - -	22½	37½	60	60	—
Quart - -	19	31	50	50	—
Pint - - -	15¾	24	39¾	40	− ¼
Half-pint - -	12¼	17½	29¾	30	− ¼
Gill - - -	9	10¾	19¾	20	− ¼
Half-gill - -	5½	4¾	10¼	10	+ ¼

Readjustment of larger measures of capacity and the half-gill.

As soon as the three larger standard measures of capacity could be conveniently spared from departmental use, they were sent for adjustment to Messrs. De Grave, on 22nd February 1870, with directions to have their rims also adjusted, which had been somewhat damaged from wear and tear. The half-gill standard measure also required to have its rim adjusted to a true plane. These four official standard measures having been so adjusted, were returned by Messrs. De Grave on 10th March, when they were again compared and verified.

Their reverification.

In the following verification of these adjusted measures the comparisons of the three larger measures were made with the large Kater balance, that of the half-gill with Oertling's balance No. 3. The two weighings of the official standard bushel were differently made; the first by the old method of counterpoising the standard weights previous to the measure of water; the second by the new method, which will presently be described, of counterpoising the measure of water before the standard weights. The thin glass disc of each of the bushel and half-bushel measures were used in their weighings; for the peck a somewhat thicker glass disc belonging to the hectolitre was used, which has no hole in it, according to the French plan. The balance grain weights used were the official set, No. 1, except where the gilt grains are specified.

ACTUAL COMPARISON of adjusted OFFICIAL STANDARD MEASURES of CAPACITY.

No.	Date of Comparison.	Weight of Water contained in compared Standard Measure.	Comparing Standard Weights.	Difference in Divisions.	Value of One Division.	Difference in Grains.
	1870.			div.	gr.	
1	March 28 -	Bushel + 100, 20 gr. (or 120·00098 gr.)	≏ Bullion 500, 400, 200, 50, 10, 5, 1, 0·5, 0·1 0·05, 0·02 oz. (or 559999·82591 gr.)	+4·0	0·8888	+3·555
2	„ „ -	Bushel + 100, 50, 20, 10 gr. (or 180·00279 gr.)	≏ Ditto ditto -	−7·75	0·7058	−5·470
3	„ 19 -	Half-bushel + 60, 10 gr. (or 70·00191 gr.)	≏ Bullion 500, 50, 30, 3, 0·3, 0·03, 0·005 oz. (or 279999·75612 gr.)	+7·925	0·52630	+4·171
4	„ 21 -	Half-bushel + 100, 10 gr. (or 110·00168 gr.)	≏ Bullion 500, 50, 30, 3, 0·2, 0·05, 0·04, 0·03, 0·01, 0·005 oz. (or 279999·74686 gr.)	+0·5	1·90471	+0·952
5	„ 14 -	Peck + 100, 6 gr. (or 106·00074 gr.)	≏ 10 lbs. (O.) + 10 lbs. (M.) (or 14000·76926 gr.)	−0·625	1·194	+0·746

Appendix VI.—*continued.*

ACTUAL COMPARISON of adjusted OFFICIAL STANDARD MEASURES of CAPACITY—*cont.*

No.	Date of Comparison.	Weight of Water contained in compared Standard Measures,	Comparing Standard Weights.	Difference in Divisions.	Value of One Division.	Difference in Grains.
	1870.					
6	March 16 -	Peck + 100 gr. (or 100·00094 gr.)	≏ 10 lbs. (O.) + 10 lbs. (M.)	+7·95	1·904	+15·137
7	„ „ -	Peck + 100, 10, 6 gr. (or 116·00148 gr.)	≏ 10 lbs. (O.) + 10 lbs. (M.)	+7·35	0·7142	+5·249
8	„ 17 -	Peck + 60, 10 gr. (or 70·00191 gr.)	≏ 10 lbs. (O.) + 10 lbs. (M.)	+2·125	0·9638	+2·048
9	„ 14 -	Half-gill + gilt grain, 0·3 + 0·1 gr. (or 0·40014 gr.)	≏ 1000, 60, 30, 3, 0·6, 0·1, 0·03, 0·02 gr. (or 1093·75700 gr.)	+5·550	0·000468	+0·002
10	„ 15 -	Half-gill + 0·3, 0·1, 0·06 gr. (or 0·45917 gr.)	≏ Ditto ditto -	−15·9	0·000879	−0·014

CORRECTION of COMPARISONS.

No.	Standard compared.	Weight of Water contained in the Standard.	Barometer.	Thermometer.	Correction for Pressure and Temperature.	Weight of Water contained in the Standard. T. = 62° F. B. = 30 in.	Error of Standard.	Mean Error.
		gr.	in.	° Fahr.	gr.	gr.	gr.	gr.
(1)	Bushel - -	560123·382	30·464	52·00	−238·512	559884·870	−115·130	−92·044
(2)		560174·359	30·464	52·00	−243·317	559931·042	−68·958	
(3)	Half-bushel - -	280073·929	30·464	51·50	−122·566	279951·363	−48·637	−38·835
(4)		280110·701	30·284	48·19	−139·735	279970·966	−29·034	
(5)	Peck - -	140107·516	30·114	50·64	−65·648	140041·868	+41·868	+39·572
(6)		140115·907	29·646	51·00	−67·030	140048·877	+48·877	
(7)		140122·020	29·635	50·74	−66·919	140055·101	+55·101	
(8)		140072·819	29·618	52·75	−60·380	140012·439	+12·439	
(9)	Half-gill - -	1094·160	30·113	50·65	−0·514	1093·646	−0·104	−0·090
(10)		1094·202	29·913	50·29	−0·528	1093·674	−0·076	

RESULTS OF COMPARISONS.

Official Standard.	Standard Weight of contents of Distilled Water.	Error in Weight.	Error in Capacity.
	gr.	gr.	cub. in.
Bushel - -	559907·955	−92·044	−0·365
Half-bushel -	279961·165	−38·835	−0·154
Peck - -	140039·572	+39·572	+0·157
Half-gill -	1093·660	−0·090	−0·000

Proceedings for reverifying the imperial standard bushel and conical measures.

The requisite duties of reverifying the imperial standard bushel and conical measures of capacity were also proceeded with by the departmental officers.

Discordant results of weighing the bushel with distilled water.

In the verification of both the official standard bushel and the imperial standard bushel by weighing their contents of distilled water, great difficulties have been experienced from the discordant results of the weighings on different days, after allowing for the requisite corrections for temperature and atmospheric pressure. These discordances have already been referred to.

Table showing these results.

The following Table shows the results of the comparisons made with purchased distilled water, which were considered unsatisfactory, more particularly as regards the imperial standard bushel :—

Date.	Standard.	Ascertained Error of Weight of Water in Excess or Deficiency.	Barometer.	Temperature of Water.	Correction for Barometer.	Correction for Thermometer.	Total Correction.	Error of Standard.
				t Fahr.				
1868.		gr.	in.	°	gr.	gr.	gr.	gr.
Dec. 3	Official bushel, 1834.	+183·5	29·63	54·055	− 7·4	−213·5	−220·9	−37·4
„ 4		+160·8	29·50	55·145	−10·1	−192·9	−203·0	−42·4
„ 5		+138·3	29·45	56·56	−11·1	−160·9	−172·0	−33·7
							Mean	−37·8
Sept. 24	Imperial bushel, 1824.	−101·4	29·7	64·44	− 6·0	+91·5	+85·5	−15·9
„ 26		−105·9	29·8	63·43	− 4·0	+51·5	+47·5	−58·4
„ 28		− 24·2	29·5	63·84	−10·0	+69·4	+59·4	+35·2
							Mean	−13·0

It may be observed that these comparisons were made under favourable circumstances, there being little variation of temperature when each standard measure was compared.

By a careful comparison of the official bushel with the standard bushel of 1824, made in the ordinary manner of comparing the local standard measures of capacity in the Department, by *measuring* their contents of water, on the

Appendix VI.—*continued.*

10th December 1869, the official bushel was found to be less in capacity than the standard measure by a quantity of water weighing 20·6 grains.

Probable causes of the discordances of weight of water.

It was at first considered that the discordances were occasioned by impurity of the distilled water used, which had been purchased for the purpose, and further operations were postponed until a still had been procured in order to distil the water required in the Standards office. But when fresh distilled water has been thus obtained, considerable discordances were still found in the results of weighing so large a quantity of water, and with so large a surface as in the bushel measure. It was evident that the difficulty arose principally from the water, and may be attributable to the following causes :—

1. Its difference of specific gravity, caused by the absorption of air, &c. from the atmosphere.
2. The evaporation of the water during the time necessarily occupied by the weighings.
3. The variations of temperature during the weighings.
4. The difficulty of obtaining an exact plane of the surface of the water.

It has been already shown that an error of 1° Fahr. in the temperature is equal to an error of upwards of 30 grains in the weight of water contained in the bushel; in like manner an error or variation of 0·001 inch in the height of the water in the bushel makes a difference of 31 grains in the determination of the weight.

Flexure of large glass disc.

The quantity and consequently the weight of water in the bushel is regulated by the glass disc, the upper surface of the cylinder and the under surface of the disc both being considered to be exactly plane. The disc which has been ordinarily used for the bushel is only ⅜ inch thick. The Astronomer Royal and Professor Miller were both of opinion that a further error might arise from the flexure of the disc over so large an opening as a circle 18 inches in diameter.

Experiment of weighing half-bushel with bushel disc.

An experiment was made of using the large disc of the bushel measure with the half bushel, so that the overhanging weight of the glass might counterbalance that over the interior of the half-bushel. The results were as follows :—

Date.	Standard.	Error of Weight of Water.	Barometer.	Thermometer, Fahr.	Correction for Barometer.	Correction for Thermometer.	Total Correction.	Error of Standard.
1870.		gr.	in.	°	gr.	gr.		gr.
Jan. 5	Half-bushel	−66·2	29·748	60·	−2·5	− 33·1	− 35·6	−101·8
„ 6		+53·7	29·726	53·85	−2·7	−109·1	−121·8	− 68·1
								Mean −84·9

The mean error of the half-bushel from the two weighings with the ordinary glass disc as before shown, being −47·3 grains, the difference from the mean not exceeding 1·7 grain, it is evident that they are much more to be relied upon than these weighings with the large disc. Some difficulty and risk of error in using it arises from the larger surface of the disc carrying off more of the water when pushed over it. There is also more risk of error in the accuracy of the plane of so large a disc.

New thick glass disc for bushel measure.

A more substantial glass disc, nearly 1 inch thick for the bushel measure, was consequently procured in December 1869, after the completion of the verification of the official standards of capacity. It was furnished by Messrs. De Grave, and was constructed specially for them by the Birmingham Plate Glass Company, and great attention was paid to the surface being a true plane.

Unsatisfactory results of these weighings.

The first weighings of the two standard bushels with the thick disc for the purpose of comparing the results were not found to be satisfactory. The results were exceedingly discordant as compared with previous weighings. Some doubt existed as to the correctness of the smaller weights stated to have been used. A regulation has therefore now been laid down, that in all such weighing where a number of weights are used, the noting of these weights shall always be checked by a second person.

Weighings of the two standard bushels with thin and thick discs.

The following are the details and results of the comparisons thus made :—

COMPARISONS of the two STANDARD BUSHELS with Thin and Thick GLASS DISCS.

Date.	Compared Standard Bushel.	Glass Disc.	Comparing Standard Weights.	Result in Division.	Value of One Division.	Result in Grains.	Temperature of Water.	Barometer.
1869.				div.	gr.	gr.	°Fahr.	in.
Dec. 14	Imperial standard, 1824.	Thin	≏Bullion standards 500, 400, 200, 50, 10, 5, 1 oz., 0·3, 0·05, 0·02, and 0·005 oz. (or 559858·23197 gr.)	−1·75	0·5485	−0·95987	63·1	29·437
„ 16	Ditto -	Thick	≏Bullion standards as above, except 0·04 and 0·02 oz. substituted for 0·3 and 0·005 oz. (or 559740·63030 gr.)	−1·25	0·83416	−1·04270	67·06	29·638
1870. Jan. 4	Official standard, 1834.	„	≏Bullion standards 500, 400, 200, 50, 10, 5, 1, 0·5, 0·3, 0·1, 0·05, 0·03, 0·32 (or 560182·21437 gr.)	+0·75	0·47057	+0·35293	59·25	29·807

RESULTS of these COMPARISONS.

Date.	Compared Standard. Bushel.	Weight of Contents of Water.	Correction for Temperature and Pressure.	Weight at 62° Fahr. and Bar. = 30 in.	Error of Bushel.	
1869.		gr.	gr.	gr.	gr.	cubic in.
December 14 -	Imperial standard, 1824 -	559857·27	+ 28·46	559885·73	−114·27	−0·453
„ 16 -	„ „	559739·59	+192·68	559932·27	− 67·73	−0·268
1870. January 4 - -	Official bushel, 1834 - -	560182·57	− 92·58	560089·99	+ 89·99	+0·356

Appendix VI.—*continued.*

Change in the order of weighing.

The mode hitherto adopted of comparing the official standard measures of capacity was to determine by counterpoise, first, the weight of the measure and the standard weights equivalent to the contents of water; and, secondly, the weight of the measure filled with water. Some risk of error arose from this order of proceeding in consequence of the temperature of the water differing from that of the air and the metal, and it was necessary after weighing the standard weights to complete the weighing of the water as rapidly as possible, to avoid variations of temperature and pressure, as well as loss of weight by evaporation of the water. With this object, one reading only was taken.

But in consequence of the discordances in the weighings, particularly of the imperial standard bushel, some further comparisons of this standard measure were made with the greatest care, the thick glass disc being used; and a change was made, as an experiment, in the order of weighing.

New method of weighing the standard bushel.

The exact method of making three fresh comparisons of the primary bushel, 1824, with the thick glass disc, may be thus described:—

The bushel was filled with distilled water some hours before the comparison was made, and covered with its disc. If the temperature of the air was found to agree with that of the water, the weighings were made within two or three hours after the filling of the bushel was completed; if a difference of temperature of the air and water were observed, further time (from 10 to 24 hours) was allowed to elapse before the weighing, in order that the temperatures might be uniform. By this means the temperature of the balance, bushel, glass disc, water, and air were always nearly identical during the weighings.

The bushel was filled by means of a small india-rubber tube, and occupied nearly one hour in filling. It was thought necessary thus to allow the distilled water opportunity of thoroughly absorbing air, so as to use the water in a constant condition.

The three comparisons were made at very different temperatures, in order to test to some extent the accuracy of the table of reductions for weighings made at extreme temperatures. The first comparison was made at 49° Fahr., the second at 71° Fahr., and the last at nearly 62°, or the standard temperature. Although great care has been made in taking these comparisons, the weights used being checked by two persons, the results are still to some extent discordant. The method of filling the bushel first with distilled water and afterwards counterpoising when empty, does not seem therefore to possess any advantage over the method employed in the reverification of the official standard measures of capacity.

ACTUAL COMPARISONS of IMPERIAL STANDARD BUSHEL with Thick GLASS DISC.

Date.	Compared.	Comparing.	Result in Divisions.	Value of One Division.	Result in Grains.	T.	B.
1870.			d.	gr.	gr.	°	in.
21 Jan.	Bushel, 1824 - - -	≏Bullion standards 500, 400, 200, 50, 10, 5, 1, 0·5, 0·1, 0·05, 0–02 oz. - - +0·4, 0·3, 0·2, 0·01 oz. - - = 559999·82591 gr.	−1·65	0·60149	−0·99245	49·1	30·309
24 Jan.	Bushel, 1824 - - - +Supplementary grain weights 200, 60, 30, 3, 2, or 295·00441 gr.	Ditto ditto -	+2·90	0·31999	+0·92797	71·205	30·449
1 Feb.	Bushel, 1824 - - - —Supplementary grain weights 100, 60, 20, 6 gr., or 186·00195 gr.	Ditto ditto -	+2·25	1·33330	+2·99992	61·8	29·977

RESULTS of these COMPARISONS.

Date.	Standard.	Weight of contents of Water.	Corrections for T. + B.	Weight of Primary. Bushel, T. 62, B. 30. By Regnault's Tables.	Error.
1870.		gr.	gr.		gr.
Jan. 21 - -	Bushel, 1824	=560435·62	−273·06	560162·56	+162·56
„ 24 - -	„ „	=559705·75	+410·96	560115·97	+115·97
Feb. 1 - -	„ „	=560188·83	− 6·48	560182·35	+182·35

The second comparison, on 24th January, at the high temperature of 71·2°, must be rejected, as it was found that great evaporation of the water occurred before the weighing could be completed. The weights and metal of the balance became quite damp, and required wiping with a cloth. There is no material discordance between the weighing of January 21 and February 1, the mean result being that the capacity of the imperial standard bushel now appears to be in excess 172·36 grains weight of water or 0·683 cubic inch.

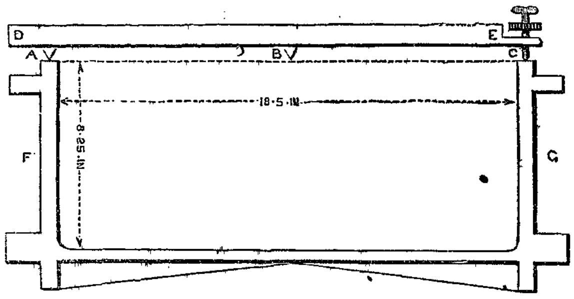
The result of these weighings of the imperial standard bushel, and of the official standard bushel as compared with them, are now reported to the Commission, and they will probably concur with me that further observations are required. Upon calling Professor Miller's attention to the several results, he states his opinion that the process of thus verifying a bushel measure is most troublesome, on account of the great weight of water and the necessity of filling the standard exactly up to the brim, and he suggests that a standard measure more resembling the cubic foot bottle would answer better. He has also suggested a new mode of ascertaining that the upper surface of the water is a plane coincident with the plane of the rim, as no better plane can be had than the surface of the water if left to itself. His suggestion is that a metallic bar D, E, provided with points A, B, and C, of which A and B are fixed, and C moveable by a micrometer screw, should be constructed. The reading of the head of the micrometer screw must be determined, at which A, B, and C are in a straight line. Then, having carefully levelled the rim of the bushel, filled with water, the points A and C are to be placed on the rim and C unscrewed until B touches the water. The reading

Appendix VI.—*continued.*

of the micrometer of C will thus show whether the plane of the water is the same as that of the rim of the bushel, or not.

The following drawing shows the form and application of such a levelling bar, as well as the exact form of the imperial standard bushel F, G, with its projecting rims. It would be desirable that the department should be furnished with a true plane, consisting of a metallic circular plate the size of the external diameter of the imperial standard bushel:—

Section of Imperial Standard Bushel, with suggested apparatus for ascertaining level of water.



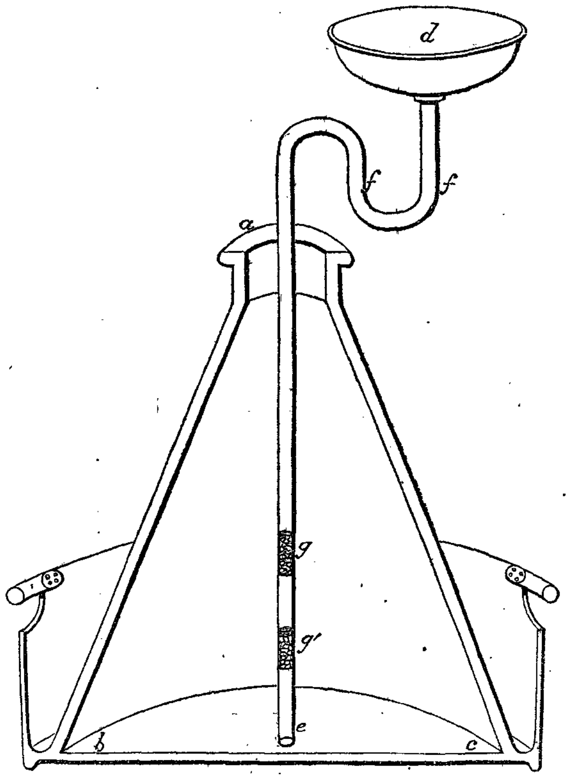
Imperial Standard bushel, diameter = 18½ in., height 8¼ in.

Best form of standard for dry and for liquid measures.

It is to be observed, with respect to the shape of standard measures of capacity, that they are required for verifying measures commonly used by the public *for dry commodities,* from the bushel to the quart, and in comparatively few instances down to the half and quarter pint or gill. For all such purposes the cylindrical form is best suited. The total amount of dry measures verified for public use in the United Kingdom in the year 1866 was 42,615, according to the returns from the inspectors. In the same period, it appears from the returns that 312,208 measures for liquids were so verified, of which the largest proportion were publicans' measures of the quart and under. The returns are, however, in this respect very incomplete. For verifying such liquid measures, conical standards would be found very convenient. In some districts, Liverpool for instance, conical standards are exclusively used for verifying liquid measures.

Reverification of Conical Standard Measures of Capacity.

The following drawing shows the exact form of the conical standard measures of capacity, and the mode adopted for filling them with distilled water:—



a, b, c, is the conical gallon.

d, e, a glass funnel for filling.

f, f, a bend in the funnel to break the force of the water and prevent air being carried down.

*g, g*¹, pieces of clean sponge inserted in the funnel to collect any air bubbles which may have been carried down.

Section of conical measure verified by Capt. H. Kater, 1825, showing the mode of filling conical measures so as to prevent bubbles of air attaching themselves to the inside of the measure.

Reverification of conical standard measures of capacity. Mode of filling them with distilled water.

By repeated experiments with a glass vessel and this bent syphon, it has been found that no air bubbles escape into the measure, and that when the funnel is withdrawn after filling, any air bubbles introduced are also withdrawn in the pieces of sponge.

Appendix VI.—*continued.*

ACTUAL COMPARISON of CONICAL STANDARD MEASURES OF CAPACITY.

No.	Date of Comparison.	Weight of Water contained in compared Standard Measure, &c.	Comparing Standard Weights.	Difference of compared Standards in Divisions.	Balance used.	Value of One Division of Balance.	Difference of compared Standard in Grains.
				div.		gr.	gr.
(1)	1869. Dec. 11	Gallon No. 1	≏10 lbs. (O.) + official grain weights (A.), 10, 3, 1 gr. (or 70014·54702 gr.)	−0·625	Kater's large balance.	0·66665	−0·416
(2)	1870. Feb. 26	„ „	≏10 lbs. (O.) + 30 gr. (A.) (or 70030·54685 gr.)	−3·150	„	1·484	−4·676
(3)	Mar. 3	„ „	≏ Do. do.	−2·125	„	3·80943	−8·095
(4)	„ 7	Quart No. 1	≏Gilt lbs. Nos. 32 and 33 + gilt gr. 2000, 1000 (No. 2), and 500, and gr. (A.) 6, 2 (or 17508·01693 gr.).	−2·750	Oertling, No. 2.	0·01999	−0·055
(5)	„ 9	„ „	Gilt lbs. Nos. 32 and 33 + gilt gr. 2000, 1000 (No. 2), and 500, and gr. (A.) 6, 1 (or 17507·01386 gr.).	−0·42	„	0·05654	−0·024
(6)	Feb. 25	Pint No. 1	≏New avoirdupois lb. No. 47 + gilt gr. 1000, No. 1, and gr. 600, 100, 30, 20, 2, 0·6 (or 8752·63409 gr.).	+9·25	„	0·01829	−0·169
(7)	March 3	„ „	≏ Do. (0·3 gr. instead of 0·6) (or 8752·33715 gr.).	−4·0	„	0·04997	+0·200
(8)	1869. Dec. 10	Gallon No 2	≏10 lbs. (O.) + bullion 0·02 oz. (or 70010·14547 gr.)	−3·0	Kater's	0·56466	−1·694
(9)	1870. Feb. 26	„ „	≏10 lbs. (O.) + gr. (A.) 30 (or 70030·54685 gr.).	−0·97	„	0·30770	−0·290
(10)	„ „	Quart No. 2	≏Gilt lbs. 32 and 33 + gilt gr. 2000 + gr. (A.) 1000, No. 2, 300, 200, 6, and 2 (or 17508·01585 gr.).	−4·5	Oertling, No. 1.	0·02937	−0·134
(11)	March 3	„ „	≏ Do. (500 gr. and 1 gr. instead of 300, 200, 6, and 2), (or 17508·01406 gr.).	−2·75	„	0·01999	−0·549
(12)	Feb. 26	Pint No. 2	≏Official lb. No. 47 + gilt gr. 1000 No. 1 + gr. (A.) 600, 100, 30, 20, 3, 0·3 (or 8753·33439 gr.).	+20·25	Oertling, No. 2.	0·07547	+1·528
(13)	March 1	„ „	≏ Do. (2 and 0·2 gr. instead of 3 and 0·3, (or 8752·23716 gr.).	+9·62	„	0·02378	+0·229

It may be observed that there is a considerable difference in the value of one division of Kater's large balance in comparisons (1), (2), and (3). This arises, as has been before remarked, from the mean resting point of the index needle being nearer to or further from the middle of the scale, at which point the balance is exactly in equilibrium.

CORRECTIONS OF COMPARISONS OF CONICAL STANDARD MEASURES OF CAPACITY.

No.	Standard compared.	Weight of Water contained in Standard.	Barometer corrected to 32° F.	Thermometer. Temperature of Water.	Correction for Pressure and Temperature.	Weight of Water sustained in Standard T. = 62° F. B. = 30 in.	Error of Standard.	Mean Error.
		gr.	in.	° Fahr.	gr.	gr.	gr.	gr.
(1)	Gallon No. 1	70014·130	29·410	57·80	−17·699	69996·431	−3·569	−3·813
(2)		70025·871	29·529	53·00	−30·305	69995·566	−4·434	
(3)		70052·452	29·595	54·85	−25·889	69996·563	−3·437	
(4)	Quart No. 1	17507·962	30·269	51·45	− 7·808	17500·154	+0·153	+0·030
(5)		17506·989	30·185	53·15	− 7·083	17499·906	−0·094	
(6)	Pint No. 1	8752·465	29·651	54·10	− 3·432	8749·033	−0·967	−0·793
(7)		8752·537	29·595	55·10	− 3·156	8749·381	−0·619	
(8)	Gallon No. 2	70008·451	29·904	60·165	− 7·968	70000·483	+0·483	+0·543
(9)		70030·257	29·529	53·30	−29·654	70000·603	+0·603	
(10)	Quart No. 2	17507·882	29·519	50·90	− 8·493	17499·389	−0·611	−0·796
(11)		17502·542	29·595	58·70	− 3·524	17499·018	−0·982	
(12)	Pint No. 2	8753·509	29·519	51·10	− 4·210	8749·299	−0·701	−0·726
(13)		8752·466	29·700	54·8	− 3·218	8749·248	−0·752	

Appendix VI.—*continued.*

Mean Results of Comparisons.

Standard Measure.	Standard Weight of Contents of Distilled Water.	Error in Weight.	Error in Capacity.
	gr.	gr.	cub. in.
Imperial Conical Gallon, No. 1	= 69996·18666	—3·81333	—0·015
Quart ,,	= 17500·03027	+0·03027	+0·000
Pint ,,	= 8749·20674	—0·79326	—0·003
Official Gallon, No. 2	= 70000·54320	+0·54320	+0·002
Quart ,,	= 17499·20354	—0·79646	—0·003
Pint ,,	= 8749·27329	—0·72671	—0·000

The reverification of all the existing legal standard measures of capacity being thus completed, an account of the verification of the new standard measures will be given in a continuation of this paper. These new measures proposed to be legalised as secondary standards will consist of,—

The standard bottle of $\frac{1}{6}$ gallon.
,, half bottle of $\frac{1}{12}$,,
,, measure of 4 fluid ounces.
,, ,, of 2 ,,
,, ,, of 1 fluid ounce.

These standard messures are now being constructed of cylindrical form by Messrs. De Grave. Duplicate standard measures are also required of the half bushel and peck, and the construction of conical standard measures to complete the series below the pint, as well as duplicates of the new standard measures stated above, in a conical form, is desirable. A description will also be given of Messrs. Tylor's new standard gallon, when delivered by them and its verification completed.

Account of new standard measures, and their verification to be given in a subsequent paper.

A series of glass measures of capacity is also being constructed by Messrs. Griffin, consisting of measures holding a single quantity, and graduated measures from a quart and the litre down to the smallest imperial and metric measure. They are of various forms, spherical and cylindrical, with narrow necks, as well as tubular, including also burettes and pipettes. With an appropriate apparatus, these glass measures will enable the specified quantities to be either delivered or measured with the greatest precision, and it will probably be found by the Commission that they may be made very useful standards for measures of this description, in which minute accuracy is required for chemical or commercial purposes, or volumetric analysis.

H. W. CHISHOLM,
Warden.

Standards Office,
March 24, 1870.

PART II.—Verification of New Standard Imperial Measures of Capacity.

Contents.

	Page
Comparison with each other of official standard measures of capacity, in binary series	91
Verification of new cylindrical standard measures of capacity	92
Verification of new glass burettes	,,
Description of burettes and attached apparatus	,,
Mode of verification	93
Actual comparisons	,,
Comparison of glass burettes with new cylindrical standard measures	95
Description of M. Salleron's drop-measurer	,,
Table of metric equivalents of new imperial measures	96
Discordances arising from difference in British and French ratios of the weight and dimensions of water	,,

Verification of New Standard Imperial Measures of Capacity.

Before proceeding to state the mode of verifying the new standard imperial measures of capacity and the results, it may be interesting to show the ascertained differences of the capacity of each standard measure of the old binary series when compared with twice the contents of the next smaller measure. This process has been effected by the ordinary method used in the departmental comparisons of local standard measures of capacity, by the measurement of their contents of water when transferred from one standard measure to the other; and the result is shown in comparison with the previous determinations.

Comparison with each other of official standard measures, in binary series.

Comparisons on 24th June 1870.

Standard Measure.	Capacity as previously determined.	Error previously ascertained.	Consequent Result of previous determinations.		Ascertained Difference by actual Measurement of the Contents of Water.
	Gr.	Gr.		Gr.	Gr.
Bushel - - =	559907·955	+92·044	= 2 half bushels	— 14	+91
Half bushel - - =	279961·165	—38·835	= 2 pecks	—109	— 1
Peck - - =	140039·572	+39·572	= 2 gallons	+ 39	+50
Gallon - - =	70000·205	+ 0·205	= 2 half gallons	+ 11	+20
Half gallon - - =	34994·488	— 5·512	= 2 quarts	— 2	+ 7
Quart - - =	17498·197	— 1·803	= 2 pints	— 1	+11
Pint - - =	8749·537	— 0·463	= 2 half pints	— 0·4	+ 4
Half pint - - =	4374·999	— 0·001	= 2 gills	+ 0·4	+ 6
Gill - - =	2187·270	— 0·230	= 2 half gills	—	+ 1
Half gill - - =	1093·308	— 0·442	—	—	—

This result is an illustration of the discordances that arise in the determination of the larger measures of capacity by the use of water when this determination is made either by weighing the contents of water, or by the measurement of the

Appendix VI.—*continued.*

water when transferred from one measure to the other. One of the largest discordances in the results above shown is in the comparison of the half bushel with two pecks, being equal to 108 grains in 280,000, or about $\frac{1}{2800}$th part. In the comparison of the quart with two pints it is $\frac{1}{1458}$th part. And yet all these comparisons have been taken with the greatest possible care.

Verification of New Cylindrical Standard Measures of Capacity.

Verification of new cylindrical standard measures of capacity.

The following new cylindrical standard measures of capacity have been constructed by Messrs. De Grave, and are made of Baily's metal, with ivory rings around the base so that they may be handled or lifted without touching the metal with the hand. Each is engraved with its proper designation. These new measures are generally similar in form to the older standard measures nearest to them in capacity, except that their diameter is about two-thirds of the height. Their approximate dimensions are now given:—

New cylindrical Standard Measure.	Internal Measurement.	
	Diameter.	Height.
	In.	In.
Standard bottle of ⅛ gallon - - -	3·6	4·5
Half do., $\frac{1}{12}$ gallon - - -	2·75	3·75
Measure of 4 fluid ounces - - -	1·8	2·7
„ 2 „ - - -	1·5	2·0
„ 1 „ - - -	1·15	1·7

The angle at the bottom of each measure is slightly rounded off, so as to prevent its holding a ring of water there.

The new measures of the bottle and half bottle are faulty in the casting, and are provisional only, until measures with more perfect castings are made. It is important for the durability of such metallic standard measures of capacity that the surface should be quite clear from defects; and it is also very requisite that the interior surface should be quite smooth and polished, in order to lessen as far as possible the cohesion of the water used for comparisons.

Actual Comparisons of the New Standard Measures.

No.	Date of Comparison.	Weight of Water contained in compared Measure.		Comparing Standard Weights.	Difference in Divisions.	Balance used.	Value of one Division.	Difference in Grains.
	1870.				Div.		Gr.	Gr.
(1)	July 20	Bottle of ⅛ gallon -	≏	1 lb. gilt gun metal, No. 33, and standard grain weights (=11666·718 gr.)	+20·0	No. 1.	0·170	+3·404
(2)	„	Half bottle, $\frac{1}{12}$ gallon + 3 gr. (=2·998 gr.)	≏	Standard grain weights (=5833·316 gr.)	−16·125	No. 1.	0·043	−0·696
(3)	„	Fluid 4 oz. + 3 + 0·3 gr. (or 3·3 gr.)	≏	Standard grain weights (=1750·008 gr.)	− 1·475	No. 5.	0·00145	−0·002
(4)	„	Fluid 2 oz. + 0·2 + 0·2 gr. (or 0·383 gr.)	≏	Standard grain weights (=875·002 gr.)	− 8·925	No. 5.	0·00197	−0·018
(5)	„	Fluid 1 oz. −0·05, 0·03 gr. (or 0·08 gr.)	≏	Standard grain weights (=437·506 gr.)	−11·75	No. 4.	0·00088	−0·010

Results of these Comparisons.

No.	Standard compared.	Weight of Water contained in compared Standard.	Air.		Water Temperature, Fahr.	Correction of Pressure and Temperature.	Weight of Water contained in the Standard. $t=62°$ F. $b=30$ in.	Error of Standard.	
			Corrected Barometer.	Temperature, Fahr.				In Grains.	In Cubic Inches.
		Gr.	In.	°	°	Gr.	Gr.	Gr.	Cub. In.
(1)	Bottle of ⅛ gallon -	11670·122	30·24	68·0	63·0	+0·85	11670·975	+4·30	+0·017
(2)	Half bottle of $\frac{1}{12}$ gallon	5835·618	30·32	68·0	62·8	+0·43	5836·045	+2·71	+0·010
(3)	4 fluid ozs. - -	1753·306	30·30	68·0	65·45	+0·432	1753·739	+3·74	+0·015
(4)	2 „ - -	875·385	30·30	67·5	59·0	−0·112	875·272	+0·27	+0·001
(5)	1 „ - -	437·415	30·11	68·5	64·75	+0·240	437·145	−0·82	−0·003

Verification of Standard Measures of capacity in the form of Glass Burettes.

Verification of standard glass burettes.

The series of glass burettes constructed by Messrs. Griffin to deliver standard measures of water or other liquid, has been already mentioned in the list of standard weights and measures, both of the Imperial and the Metric system, which are proposed to be legalised as secondary standards.

These burettes have all been constructed upon one uniform plan, and with the exception of a few of the smallest size, each is fitted with a brass collar and screw, so as to be attached to a filling and delivering apparatus, shown in the annexed figure.

A brass rod A, fixed upon a pedestal having levelling screws, serves to support, by the pressure of the side screws *b* against a moveable collar, the brass fittings to which the glass burette C is attached by the screw *d*, in the brass

Appendix VI.—*continued.*

collar cemented to the glass burette. To the upper part of the brass fittings the glass reservoir of water E is fixed with cement. The lower part of the burette is steadied by a small brass ring covered with baize attached to the rod A by the screw *f* pressing against a moveable collar. The water from E is allowed to run into the burette by opening the stopcock *g*. The admission of air to the top of the burette is regulated by the stopcock *h* and a very minute orifice at *i*, as well as by a larger orifice at *k*, when required, which can also be closed by a stopcock. The defining line of the standard measure of the burette is shown at *l*. A smaller burette stand M serves to support a second burette N, into which the contents of the burette C can be delivered for the purpose of comparison by means of the funnel *j*. A small brass tube is inserted in the brass conducting tube above *d*, and extends about half an inch below *d*, being slightly curved at its lower extremity. When the water is let run from E into the burette, it is conducted inside this small tube against the side of the burette, and thus prevents air bubbles being formed, and the stopcocks *h* and *k* being open, the air at the top of the burette escapes freely on the outside of the small brass tube through the air tube leading to the aperture at *k*.

Mode of verification.

There are two modes of verifying these glass burettes.

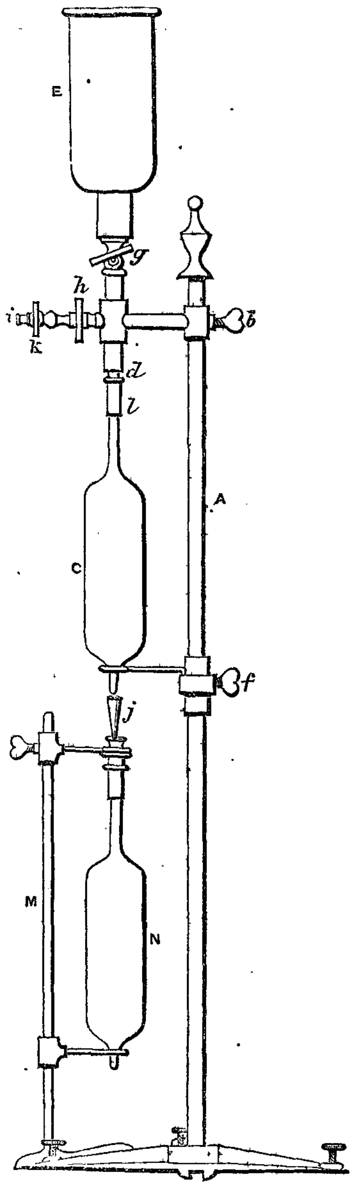
One mode is by filling them with distilled water up to the defining line, and then discharging the contents of water, leaving the inside wet. After attaching a small piece of soft wax to the discharging point, the burette is to be unscrewed from the apparatus, and accurately counterpoised in a balance. It is next to be re-attached to the apparatus and re-filled with distilled water up to the defining line, and the temperature of the water having been ascertained, it is to be re-weighed to see whether the additional weight required to counterpoise it corresponds with the proper standard weight of its contents of distilled water at the standard temperature of 62° Fahr., and barometer at 30 inches, the requisite corrections being made for any ascertained difference from this temperature and barometric pressure.

The second mode is to verify the glass burette with the metallic cylindrical standard corresponding with it in capacity, by discharging its contents of distilled water into the metallic standard, when at the standard temperature and atmospheric pressure (or making the requisite corrections), and determining how nearly the contents fill the metallic standard.

If this second method is employed, after the first, it will form a means of checking the accuracy of the previous determination by the weight of water both of the glass burette and the metallic standard.

The following verifications of the glass burettes for imperial measures of capacity were made by the first of these two methods. Messrs. Griffin have their own standard measures, which have been verified according to this mode by Mr. J. Griffin, F.C.S., and each burette has been marked with a provisional defining line on a slip of paper gummed on the outside of the tube. The capacity thus indicated has in each case been tested by the official comparisons, and any correction required has been made before marking the permanent defining line with a diamond.

As it is of the utmost importance that all the burettes and the instruments used with them should be thoroughly clean, they are all washed before using with a solution of caustic potash. If the inside of one burette is slightly greasy, or if even undistilled water is used, it will not deliver the same quantity.



The burette measures of 50 grains and under are of different construction from the larger burettes. Being so small they are not intended to be used with the burette stand, and are merely graduated glass tubes, two in number: one tube is graduated into 50, 30, 20, and 10 grains, the other tube into 5, 3, 2, and 1 grain.

Comparisons of Glass Burettes.

Actual comparisons of glass burettes.

No.	Date of Comparison.	Description of Glass Burette compared.	Standard Weight of Contents of distilled Water, *t.* = 62° Fahr., *b.* = 30 in.	Weight of comparing Standards; Decimal Grain Weights.	Difference of compared Glass Burette in Divisions.	Value of one Division.	Difference of compared Glass Burette in Grains.
	1870.		Gr.	Gr.	Div.	Gr. Balance	Gr.
(1)	June 24	⅙ gallon, No. 1 - -	11666·6	11666·6	+ 9·75	0·15685 (No. 1)	+1·50
(2)	” ”	” No. 2 - -	”	”	+ 5·05	0·14185 ”	+0·70
(3)	” ”	1/12 gallon, No. 1 - -	5833·3	5833·3	− 5·25	0·04422 (No. 2)	−0·20
(4)	” ”	” No. 2 - -	”	”	+19·00	0·01110 ”	+0·20
(5)	July 21	4 fluid ounces, No. 1 -	1750·00	1750·01	+28·00	0·004 ”	+0·11
(6)	” ”	2 ” ” -	875·00	875·11	+23·75	0·002 (No. 5)	+0·04
(7)	” 19	1 ” ” -	437·50	437·50	—	—	—
(8)	” ”	½ ” ” -	218·75	218·80	—	—	—

Appendix VI.—*continued.*

Comparison of Glass Burettes—cont.

No.	Date of Comparison.	Description of Glass Burette compared.	Standard Weight of Contents of distilled Water, $t.=62°$ Fahr., $b.=30$ in.	Weight of comparing Standards; Decimal Grain Weights.	Difference of compared Glass Burette in Divisions.	Value of one Division.		Difference of compared Glass Burette in Grains.
	1870.	Grains Weight of Water.	Gr.	Gr.	Div.	Gr.	Balance	Gr.
(9)	July 2	7,000 No. 1 - -	7000	7000·00	− 4·87	0·027	(No. 2)	+0·134
(10)	" 19	4,000 " - -	4000	4000·01	+ 0·35	0·003	(No. 5)	−0·001
(11)	" "	2,000 " - -	2000	2000·00	—	—		—
(12)	" 21	1,000 " - -	1000	1000·00	+27·00	—		—
(13)	" "	500 " - -	500	500·01	+22·00	—		—
(14)	" 19	300 " - -	300	300·00	The true measure ascertained by adding minute quantities of water to the burette until the reading of the balance index showed a nearly accurate equipoise.			
(15)	" "	200 " - -	200	199·99				
(16)	" "	100 " - -	100	100·00				
(17)	" 22	50 " - -	50	50·00				
(18)	" "	30 " - -	30	30·00				
(19)	" "	20 " - -	20	20·00				
(20)	" "	10 " - -	10	10·00				
(21)	" 21	5 " - -	5	5·37				
(22)	" "	3 " - -	3	3·35				
(23)	" "	2 " - -	2	2·11				
(24)	" "	1 " - -	1	1·15				
		Cubic Inch.						
(25)	" "	10 No. 1 - -	2524·580	2524·51	+ 6·5	0·005	(No. 2)	+0·037
(26)	" "	5 " - -	1262·290	1262·31	+17·5	0·001	(No. 5)	+0·023
(27)	" "	2 " - -	504·916	504·98	+ 4·05	0·004	"	+0·017
(28)	" "	1 " - -	252·458	252·46	− 4·02	0·001	"	−0·005
(29)	" "	0·5 No 1 - -	126·229	126·232	+11·45	0·003	"	+0·041
(30)	" 25	0·2 " - -	50·492	50·692	+ 2·5	0·001	"	+0·003
(31)	" 22	0·1 " - -	25·246	25·250	−45·37	0·002	"	−0·092

Reductions of Comparisons of Glass Burettes.

Number.	Description of Glass Burette.	Ascertained Error, in Excess or in Deficiency.	Temperature of Water.	Temperature of Air.	Corrected Barometer.
		Grains.	°	°	Inches.
(1)	$\frac{1}{6}$ gallon, No. 1 -	+1·50	62·85	62	29·93
(2)	" No. 2 -	+0·70	62·80	62	29·93
(3)	$\frac{1}{12}$ gallon, No. 1 -	−0·20	62·80	62	29·97
(4)	" No. 2 -	+0·20	62·60	62	29·97
(5)	4 fluid ozs., No. 1 -	+0·10	62·0	68	30·25
(6)	2 " -	+0·15	62·0	68	30·25
(7)	1 " -	0·00	62·3	68	30·20
(8)	$\frac{1}{2}$ " -	+0·05	62·0	68	30·20
(9)	7,000 grains, No. 1 -	−0·14	63·0	63	30·07
(10)	4,000 "	+0·01	62·2	68	30·20
(11)	2,000 " -	0·00	62·0	69	30·20
(12)	1,000 " -	+0·11	62·3	68	30·25
(13)	500 " -	+0·04	62·0	68	30·26
(14)	300 " -	0·00	62·0	68	30·2
(15)	200 " -	0·00	62·0	68	30·2
(16)	100 " -	0·00	61·9	68	30·2
(17)	50 " -	0·00	62·5	69	30·2
(18)	30 " -	0·00	62·5	69	30·2
(19)	20 " -	0·00	62·5	69	30·2
(20)	10 " -	0·00	62·5	69	30·2
(21)	5 " -	+0·37	62·0	68	30·25

Appendix VI.—*continued.*

Reductions of Comparisons of Glass Burettes—cont.

Number.	Description of Glass Burette.	Ascertained Error, in Excess or in Deficiency.	Temperature of Water.	Temperature of Air.	Corrected Barometer.
		Grains.	°	°	Inches.
(22)	3 grains, No. 1 -	+0·35	62·0	68	30·25
(23)	2 ,, -	+0·11	62·0	68	30·25
(24)	1 ,, -	+0·15	62·0	68	30·25
(25)	10 cubic inch, No. 1	−0·03	61·9	68	30·02
(26)	5 ,, -	+0·04	61·9	63	30·07
(27)	2 ,, -	+0·06	62·5	68	30·25
(28)	1 ,, -	0·00	63·5	68	30·25
(29)	0·5 ,, -	+0·04	62·0	69	30·22
(30)	0·2 ,, -	+0·20	62·0	71	29·95
(31)	0·1 ,, -	−0·10	62·0	68	30·20

As all these comparisons were taken at very nearly the standard temperature of 62° Fahrenheit and barometric pressure of 30 inches, no further correction appears to be requisite.

Before arriving at these results, various adjustments were made in the measure of all these burettes, except those numbered (21) to (24), which have been left with Messrs. Griffin's original defining lines.

There are duplicates of each standard glass burette, numbered 2 respectively. The set No. 2 will be verified as soon possible, so that in case of any of the set No. 1 being damaged, it may be immediately replaced.

Comparison of Glass Burettes, with Cylindrical Metal Standard Measures.

Comparison of glass burettes with new cylindrical metal measures.

These comparisons were made by filling the burettes to the defining point, as provisionally marked on the slip of paper attached to the neck of each burette, and then allowing their content to run into the metallic standard. The results were as follows :—

Number.	Date of Comparison.	Temperature of Water.	Air.		Denomination of Standard Measure.	Baily's Metal Measure ≏ Glass Burette.	Relative Difference of Measure, as previously ascertained.
			Temperature.	Barometer.			
		°	°	In.		Grains.	Grains.
(1)	1870, July 21	62	68	30·2	Bottle of ⅛ gall.	No. 1 +4	+2·80
(2)						No. 2 +4	+3·60
(3)					Half ,, $\frac{1}{12}$,, -	No. 1 +2	+2·91
(4)						No. 2 +3	+2·51
(5)	,, 22	63	68	30·25	4 fluid ozs. -	+4	+3·64
(6)					2 ,, -	0·0	+0·12
(7)					1 ,, -	−2·0	−0·82

The differences in these two results are very small, considering that there is no certainty that exactly the same quantity of water remains in the glass burette after each delivery. One drop of water let fall from one of the burettes is nearly equivalent to a grain.

Description of M. Salleron's drop-measurer.

The following observations on the weight of a drop of water and of other liquids are taken from the description of a *drop-measurer*, which has been procured for the Standards Department from M. Salleron at Paris, and an account of which is contained in the printed catalogue of his instruments.

The weight of each drop of liquid which falls from a flask or other vessel must be variable, from—

1. The difference of density of the several liquids;
2. The difference of cohesion of such liquids;
3. The dimensions of the neck of the flask or vessel from which the liquid is dropped.

These variations must always arise, whatever may be the skill of the manipulator who lets the drops fall.

For example, we may take water and ether; a drop of each of these liquids falling from the same narrow orifice will weigh, of water 50 milligrams, of ether 15 milligrams.

The practice of giving doses of liquid medicines according to the number of drops counted, is therefore very inexact, and may perhaps be productive of serious consequences, when applied to substances which act with great energy on the animal economy. It is consequently desirable that instead of this practice, a method should be substituted by which drops of equal weight may always be given. This object is stated to be attained by M. Salleron's drop-measurer, of which the following is a description :—

The drop-measurer consists of a small globular glass flask, having a very small lateral tube, through which the liquid is let fall drop by drop. The dimensions of the neck of this tube are determined by the weight of a drop of distilled water, which is assumed to be 5 centigrams (0·77 grain), this being taken by M. Salleron as his unit of drop-measure. Twenty drops of distilled water thus weigh one gramme, and the drop-measure is stated to be so accurately constructed, that when twenty drops of water were let fall from it on several different occasions, and weighed in an analytical balance, they always gave the same weight of one gramme.

It has already been mentioned that drops of various liquids having different specific gravities and cohesive force, will have very different weights. M. Salleron gives tables

Appendix VI.—*continued.*

of various liquids used in medicine, showing the weight of each drop from his drop-measurer, and the number of drops which weigh a gramme. The following is an extract from these tables:—

——	Weight of One Drop.	Number of Drops for One Gramme.
	Gramme.	
Pure distilled water - - -	0·0500	20
Glycerine - - - -	0·0416	24
Orange flower water - - -	0·0384	26
Sulphuric acid - - - -	0·0350	28
Olive oil - - - -	0·0212	47
Nitric acid - - - -	0·0189	53
Chloroform - - - -	0·0166	60
Alcohol at 86° - - - -	0·0160	62
Sulphuric ether at 60° - - -	0·0111	90

Metric equivalents of these new standard Imperial measures of capacity.

In continuation of the table of Imperial and Metric equivalents appended to the Second Report of the Commission, the following table shows the Imperial and Metric equivalents of the new standard Imperial measures of capacity:—

Fluid Ounces.	Grains.	Cubic Inches.	Grammes, or Cubic Centimetres.
40	=17500·00	=69·31840	=1133·98162
20	= 8750·00	=34·65920	= 566·99081
10	= 4375·00	=17·32960	= 283·49540
5	= 2187·50	= 8·66480	= 141·74770
4	= 1750·00	= 6·93184	= 113·39816
2½	= 1093·75	= 4·33240	= 70·87485
2	= 875·00	= 3·46592	= 56·69908
1	= 437·50	= 1·73296	= 28·34954
½	= 218·75	= 0·86648	= 14·17477

Cubic Inches.	Grains.	Fluid Ounces.	Grammes.
10	=2524·580	=5·77040	=163·59013
5	=1262·290	=2·88520	= 81·79506
2	= 504·916	=1·15408	= 32·71802
1	= 252·458	=0·57704	= 16·35901

Grains.	Cubic Inches.	Fluid Ounces.	Grammes.
7,000	=27·7274	=16·00000	=453·59265
4,000	=15·8442	= 9·14303	=259·19580
2,000	= 7·9221	= 4·57151	=129·59790
1,000	= 3·9610	= 2·28575	= 64·79895
500	= 1·9805	= 1·14287	= 32·39947
300	= 1·1883	= 0·68572	= 19·43968
200	= 0·7922	= 0·45715	= 12·95979
100	= 0·3961	= 0·22857	= 6·47989

These results are obtained from Table VI. of Appendix VII. to the Second Report of the Commission, viz., by reducing Imperial grains to Metric grammes.

Discordances arising from differences in British and French ratios of weight and dimensions of water.

But different results (1135·86477 grms., 163·86180 grms., 454·34616 grms., &c.) are respectively obtained from Table III. of the same Appendix, viz., if the cubic inches are reduced to grammes by taking their equivalent cubic centimetres.

Such discordances must necessarily occur when the ratio of the cubic inch to the grain differs from the ratio of the gramme to the cubic centimetre. It has been already shown in Appendix VI. to the Second Report of the Commission, that whilst according to the French determination of M. Lefevre Gineau, the weight of a cubic decimetre of distilled water at its maximum density, is equal to 1,000 grammes, its weight according to the British determination of Sir George Shuckburgh and Captain Kater would be 1000·480 grammes. Such discordances must therefore always exist so long as the ratio between the weight of a given quantity of water and its dimensions remains to be accurately determined and accepted in the different countries of the civilised world.

H. W. CHISHOLM,
Warden.

Standards Department,
27th July 1870.

APPENDIX VII.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—RE-VERIFICATION of OFFICIAL STANDARD YARD and other STANDARD IMPERIAL MEASURES OF LENGTH; COMPARISON and VERIFICATION of NEW IMPERIAL STANDARDS of LENGTH.

PART I.—RE-VERIFICATION of OFFICIAL STANDARD YARD, and COMPARISON and VERIFICATION of other STANDARD MEASURES of LENGTH.

CONTENTS.

Page

Description of official Standard yard - - - 97
  Its original verification by Capt. Kater, in 1825 - „
  In terms of the Shuckburgh scale - - - „
  Reduced to terms of the Imperial Standard - - „
  Untrustworthy comparisons with Shuckburgh scale - „
  Three copies of official Standard yard, verified by Capt. Kater, for Edinburgh, Dublin, and London - „
  Preliminary re-verification in 1866 - - - „
Description of new microscopic comparing apparatus - 98
Preliminary measurement in 1866, of one division of micrometer No. 1 - - - - - - - „
New subdivided inch measure - - - - „
Description of new subdivided Standard yard and metre, SS. - - - - - - - - „
Value of one division of each micrometer since ascertained 99
Decimal tables of values of one division of each micrometer - - - - - - - - „
Description of new contact apparatus - - - „
Verification of contact pieces for spherical terminations - „
New contact pieces for rectangular terminations - - 100
Their verification - - - - - - - „

Page

Official directions for comparisons with the microscopic apparatus - - - - - - - 100
Form of noting and recording comparisons - - „
Re-verification of official Standard yard of 1825 - - „
Length of ancient standard yards in terms of the Imperial Standards - - - - - - 102
Description of Kater's four Standard yards with gold points, and their original verification - - - - „
Their re-verification with the Imperial Standard yard - „
Re-verification of Line Standard yard, bronze No. 6 - „
Comparison of flat brass scale No. 48, with bronze No. 6 - 103
Verification of yard on new subdivided Standard SS. - „
New Commercial Standard of Imperial and Metric length CS, its description and comparing apparatus attached - 104
Its preliminary verification, and adoption for departmental use - - - - - - - - 105
Official Minute, 3rd December 1869 - - - „
Completion and fixing of the comparing apparatus - „
Definite verification of New Commercial Standard yard - „
Directions for using the comparing apparatus - - „
Verification of subdivision of standard yard, &c., to be stated in subsequent papers - - - - „

Description of official standard yard.

The proposed mode of comparing and re-verifying the official standard yard, consisting of both the rod and the bed constructed in 1825, and since used for the comparison of local standard measures of length, has been stated in App. III., p. 21.

The brass rod is to be considered as merely an auxiliary measure to the bed, which constitutes the standard yard. The standard was defined by Capt. Kater to be the brass bar with rectangular steel terminations of the same width as the bar and projecting above its surface; "the distance between the interior "faces of the steel terminations is intended to be equal "to the length of the imperial standard yard." The bar is of brass, one inch square, and the standard was constructed by Dollond.

Its original verification by Capt. Kater, in 1825.

In his paper printed on Phil. Trans. 1826, Capt. Kater thus describes the mode in which this official standard was verified by him in 1825:—

in terms of the Shuckburgh standard scale.

"Two bars of brass were prepared ¾ inch square and rather less than 18 inches long, they were terminated by planes at right angles to their length; and upon the upper surface of each bar, very near the end, a fine transverse line was drawn; the other ends of the bars being then placed in contact and kept so by springs, the distance between the lines was taken by means of two micrometer microscopes fixed to a bar of wood and referred to Sir George Shuckburgh's scale; which scale as has already been remarked, does not sensibly differ from the imperial standard yard.

"The distance between the lines was found by numerous comparisons to be 919 divisions of the micrometer less than the standard yard, each division of the micrometer being equal to $\frac{1}{23363}$ inch (0·0000428 inch).

"The brass bars were then placed upon the standard to be examined, their marked end being next each other, and their opposite extremities kept in contact with the steel faces by a spring introduced between the bars, a part below the surface being cut away for that purpose. The distance between the lines was then measured by the micrometer misroscope, which distance, had the standard been perfectly correct, would have been equal to what the distance of the lines in the former position of the bars wanted of 36 inches.

"The distance between the lines upon the brass bars was found by the mean of 6 measurements to be 918·2 divisions of the micrometer, which differs so little from 919 divisions, that this standard yard may be considered as perfectly correct."

Reduced to terms of the imperial standard.

According to Capt. Kater's measurement therefore, the official standard yard was 0·8 divisions, or 0·00003424 in. less than the Shuckburgh standard yard. The length of the yard on the Shuckburgh scale (0—36 inches) may be deduced, in terms of the existing Imperial standard, from the Astronomer Royal's report of 1857:

(P. 44.) Shuckburgh scale, 0—36 in. - } = Brass bar No. 2 - } +0·000006 in.
(P. 81.) Brass bar No. 2 - { = Imperial Standard } +0·000296 „

∴ Shuckburgh scale, 0—36 in. - } = Imperial Standard } +0·000302 „

And since according to Kater's measurement in 1824—

Official Standard yard - - } = Shuckburgh scale - } −0·000034 „
∴ Official Standard yard - - } = Imperial Standard } +0·000268 „

Untrustworthy comparison with the Shuckburgh scale.

It was, however, considered by the Astronomer Royal (Report p. 21), that little importance was to be attached to the Shuckburgh scale itself, on account of its imperfections and the discordances in its comparisons; and Mr. Sheepshanks (p. 44) did not place much trust in Kater's comparisons, on account of the objectionable mode of resting the mircroscopical apparatus upon the scale.

Three copies, by Kater, for Edinburgh, Dublin, and London.

Three other standard yards with steel terminations, similar to the official standard, were also verified at the same time by Capt. Kater, being described as No. 2, 3, and 4, and were deposited at the three metropolitan cities of Edinburgh, Dublin, and London respectively. Their errors respectively were found to be.—

No. 2 - -	9 div.	or 0·00038 inch	too short.
No. 3 - -	5 „	or 0·00021 „	too long.
No. 4 - -	5 „	or 0·00021 „	too short.

As all these standard yards were intended merely for the purpose of sizing those employed in commerce, Capt. Kater considered the differences as trifling and to be utterly disregarded.

Preliminary re-verification in 1856.

A preliminary re-verification of the official standard yard was made in 1866, the details of which are stated in App. III., p. 21, the result showing the official standard to be 0·001125 inch less than the Imperial standard. The final comparison has been delayed until all the alterations in the microscopical comparing apparatus

Appendix VII.—*continued.*

were completed, and the subdivided standard yard was also furnished to the department, so as to enable the value of one division of each of the micrometers to be accurately determined.

Description of new microscopic comparing apparatus.

The following is a description of the microscopical comparing apparatus for measures of length, as enlarged and improved by Messrs. Troughton and Simms, and now fixed in the large room on the first floor of the old tower:—

Description of the Microscopic Comparing Apparatus.

This apparatus consists of two principal parts, viz., the carriage or base for supporting the comparing and compared measuring bars, when placed upon it in the proper position for comparison; and the micrometer microscopes for viewing and comparing the defining lines of the measuring bars.

Each of these two parts of the apparatus is fitted with the requisite appliances for giving it motion in a lateral, longitudinal, or vertical direction,—[*See plan, Plate* 1.]

1. The carriage part of the apparatus includes a strong iron travelling platform x (Fig. 1, 2,) about 6 feet by 2, moving longitudinally by means of wheels W, W, over three iron rails y', y'', y''', which are firmly bolted to a levelled stone floor, and are exactly parallel with the front line of the stone shelf z upon which the microscopes are fixed. A plan of these rails is shown separately in Fig. 4. The first or outside rail y' receives upon a raised tenon, two grooved wheels fixed near to the outer ends of the travelling platform. The centre rail y'' receives in a groove a single guiding wheel fixed near the centre of the platform. Upon the third or inside rail y''' two wheels travel having flat rims, these wheels being attached to the inner ends of the platform x. The wheels enable the platform to be moved longitudinally any distance from end to end of the stone shelf, either by pushing it along, or a more regulated motion is obtained by turning the handles of the lever rods m, m. These lever rods act by means of cog wheels s', s', upon a strong iron rod or axle s, s, with which the wheels are connected.

Resting upon the travelling platform x, is an iron frame R, R, carrying two upright iron supports R′, R′, to which is attached by means of large screws o, o, the thick gun metal horizontal plate l'. Upon this plate two others l'', l''', rest, that bear the measuring bars under comparison. The whole of this supporting frame can be easily moved across the platform in a line at right angles to the front of the stone shelf carrying the microscopes, by means of the handles of a long lever n, attached to the travelling platform x.

By this convenient motion of the frame R, R, either backwards or forwards, the defining lines of the two measuring bars can be successively brought under the microscopes for the purposes of comparison. To keep the frame R, R, in a horizontal plane when moved across the platform, and to equalize the friction on both its sides, it is supported by three wheels, T, U, V, nearly equal distances apart. The two front wheels, T, V, have different rims, one wheel T having a grooved edge, the other V having a flat perimeter like the third wheel U (Fig. 2).

But the more important part of the carriage is composed of three gun metal slabs, l', l'', l''', accurately planed, and resting one on the other, which support the measuring bars under comparison. The lower slab l' is 45 in. long, 4¼ in. broad, and ¾ in. thick; l'' is 42 in. long, 3½ in. broad, and ½ in. thick, and l''' is 40½ in. long, 5⅛ in. broad, and ½ in. thick. These slabs can be raised or lowered by the two large screws, o, o, working in a socket underneath the lower slab, and which serve for the preliminary adjustment of the height of the measuring bars under the microscopes, Nos. 1, 2, 3, and 4. The middle slab l'' can be moved backwards and forwards upon l' by the screws k, k, working against its side; the upper slab l''', which immediately supports the bars, can be moved longitudinally upon l'' by the screw i operating against its end. The screw i has a micrometer head, and can thus be employed either for longitudinal motion or for adjustment or measurement. This micrometer head is divided into 100 divisions, and 25 divisions are about equal to 0·01 inch. The upper slab l''' also carries the four lever frames, and sets of rollers, e' e', which are fixed to it by adjustable screws. The measuring bars are placed for comparison upon these lever frames, in order to prevent any flexure that might arise if the bars were placed directly on the gun metal slabs, caused by difference of temperature of the metals, and also to permit of the free expansion of the bars. The height of the defining lines of the measuring bars resting upon these rollers can be finally adjusted by the winch handles, e, f, of screws, which elevate or depress the central axis of each lever frame. By means of the screws k, k, the bars may be either moved backwards and forwards, or their position adjusted by making the axes of the two bars parallel to the line joining the optical axes of the microscopes.

2. The second part of the comparing apparatus is composed of the four micrometer microscopes, Nos. 1, 2, 3, and 4, and their auxiliary apparatus. The four microscopes are attached to a strong stone slab z, z, securely supported by cantilevers fixed to the stone wall of the room. This stone shelf is 20 feet long, 20 inches in breadth, and 2¾ in. thick, its upper surface being 42 inches from the floor. The eye piece of each microscope is 9¾ in. above the slab. Two of the microscopes, Nos. 1 and 2, are at present fixed by screws and lewises to the shelf, the centre of their fields being exactly 36 inches apart, for the more convenient comparison of standard yard measures. The other two microscopes, Nos. 3 and 4 are moveable to any part of the stone shelf for comparison of measures of length other than the yard or 36 inches. They are kept sufficiently steady in their places by the heavy weight of the iron plates a'', (Fig. 2), to which they are attached. The manner in which the light from the oil lamps p, p, is transmitted to the defining lines of the measuring bars under comparison through the pierced glass prisms g, g, g, g, is shown in Fig. 6.

Each microscope is furnished with a micrometer screw, the head being divided into 100 parts. Moving in connexion with the micrometers are the usual cobweb cross and parallel cobwebs, by means of which the relative position of the defining lines on the bars is ascertained and read off. Each microscope is provided with a spirit level, and with screws for accurate levelling and for focal adjustment.

The front elevation of the whole apparatus in Fig. 1 shows the travelling platform x, the iron frame or carriage R, the lamps p, p, and the microscopes, Nos. 1, 2, 3, and 4. It also shows by a dotted line the position of the mahogany box j j which incloses the gun metal plates and measuring bars at the time of comparison, and serves to prevent any variation of temperature of the bars. This box is shown in projection in Fig. 3, the top or lid of the box having slits through which the bars within the box are viewed. As a further guard against the measuring bars when under observation being affected by change of temperature, a thick woollen rug, with holes cut in it under the microscopes, is thrown over the box containing the bars.

Prelimin measure- ment of (division of the micromet

At p. 25 of Appendix III. will be found a statement of the preliminary measurement on 16 June 1865, of one division of micrometer No. 1, based upon Messrs. Troughton and Simms' most accurately subdivided inch measure, containing both tenths and hundredths of an inch, the actual errors of the subdivisions being noted. The mean result is, 1 div. = 0·0000317 inch.

New sub vided inc measure.

Since this period a similar subdivided inch has been furnished to the Department by Messrs. Troughton and Simms. The defining lines are cut upon a slip of silver let into a small bar of gun metal, about 2 inches long, ¾ inch wide, and ½ inch deep. The inch is divided into tenths, numbered 1, 2, 3, &c., from left to right, the first tenth being subdivided into ten hundredths of an inch.

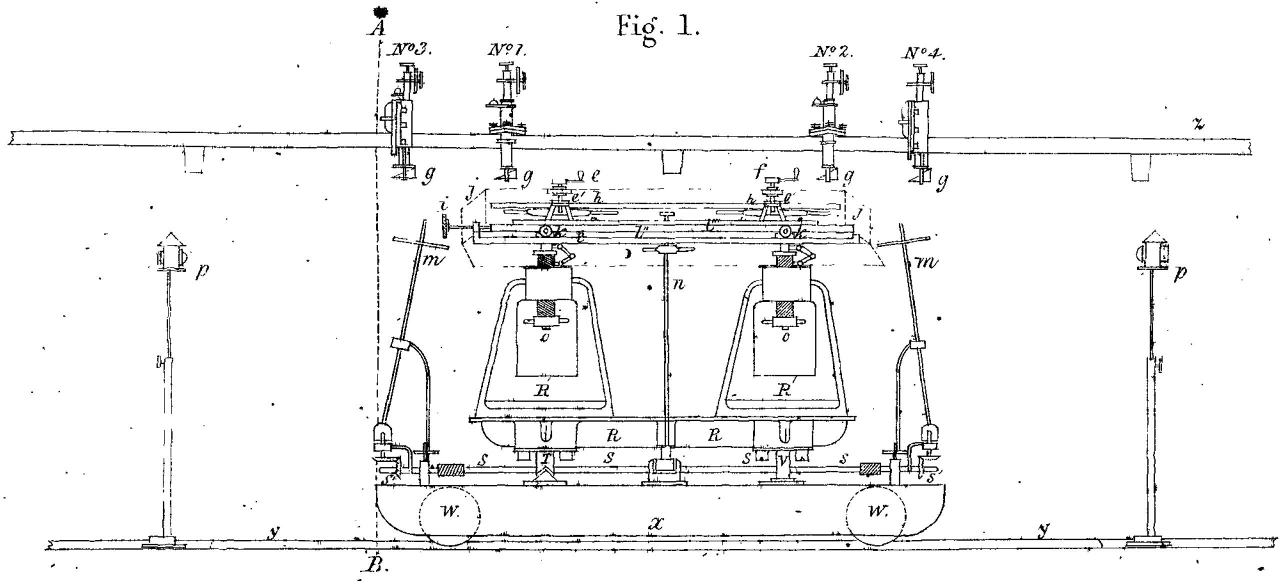
Descriptic of new subdivide standard yard and metre.

The new subdivided standard yard, having also a subdivided metre marked on the bar, was delivered at the Department on 21 May 1868, together with the improved comparing apparatus and its two additional microscopes. This standard bar has been described at p. 34 of the second report of the Commission, and a drawing of that portion which contains the defining lines is there shown. Since the date of that paper, the bar has been returned to Messrs. Troughton and Simms, in order that figures might be engraved to distinguish the several minute subdivisions, the absence of such distinguishing marks having been the cause of some difficulty in the comparisons under the microscopes, as well as risk of mistake.

The inch 36–7, is divided into tenths, and now numbered 1, 2, 3, &c., each tenth being subdivided into hundredths of an inch. The inch 37–8, divided into twelfths similarly numbered; and the inch 38–9, divided into eighths, is also numbered, each eighth being subdivided into sixteenths of an inch. The inch 39–40 has also been divided into tenths, similarly numbered,

MICROSCOPIC COMPARING APPARATUS

Fig. 1.


A
No. 3.
No. 1.
No. 2.
No. 4.
z
g
g
e
f
e'
h
h
e'
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g
j
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o
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R
R'
R
R
s
s
s
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s
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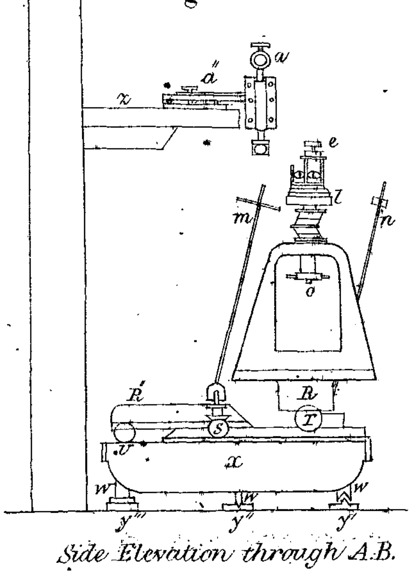
W.
W.
x
y
y
B.

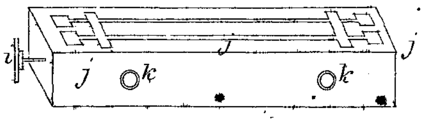
Front Elevation of the Apparatus.
Scale 45 mm

Fig 2.


z
a''
w
e
l
m
n
o
R'
R
S
T
v
x
w
w
w
y'''
y''
y'

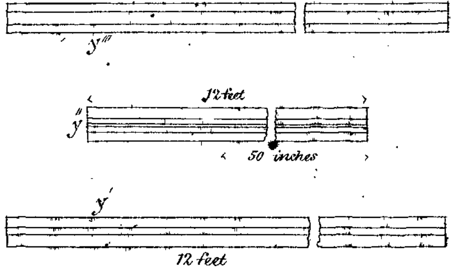
Side Elevation through A.B.
Scale 45 mm

Fig. 3.



Comparing box.

Fig. 4.


12 feet
y'''
12 feet
y''
50 inches
y'
12 feet

Plan of Rails.
Scale 45 mm

Fig. 6.

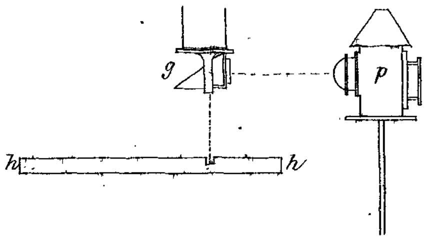


Diagram shewing the manner in which the light is transmitted from the lamp through the pierced prism of the microscope on to the bar under comparison

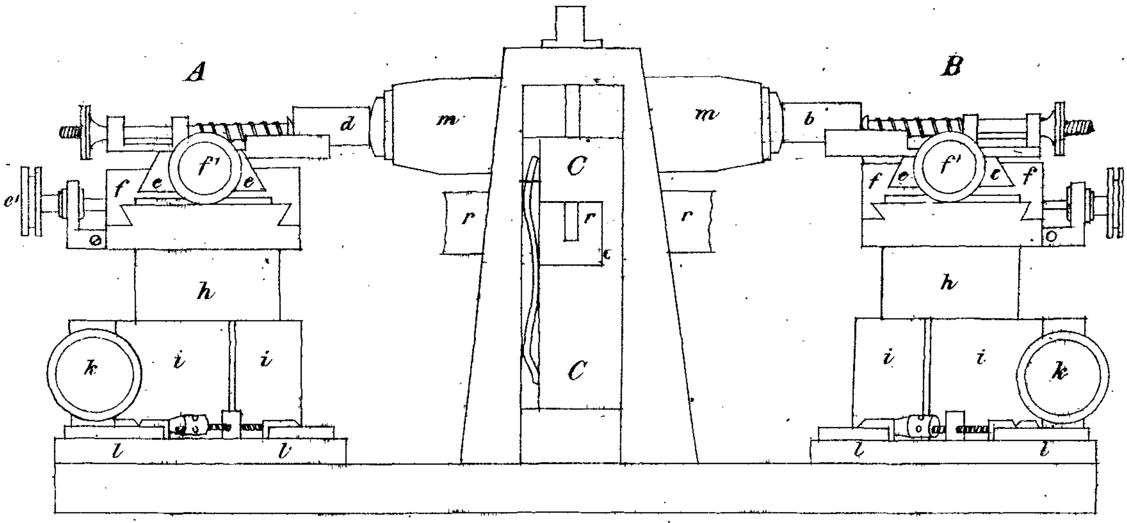
Scale 112 mm

CONTACT APPARATUS,

Plate 2.

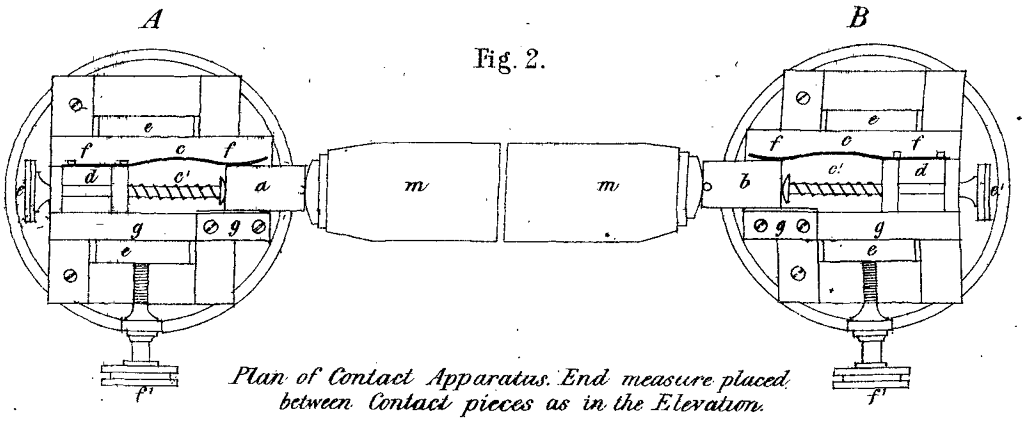
One half (½) real size.

Fig. 1.



Elevation of Contact Apparatus, shewing an End measure (m) placed between the Contact pieces (a. b) and supported by rollers (r. r.)

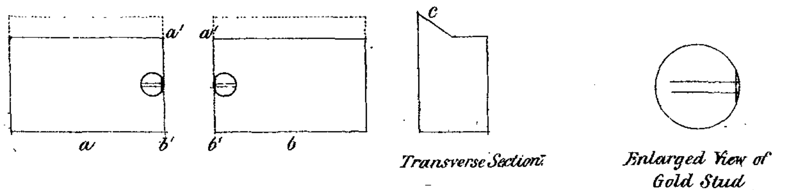
Fig. 2.



Plan of Contact Apparatus. End measure placed between Contact pieces as in the Elevation.

Fig. 3.

The two Contact pieces (a. b) used for end measures with spherical terminations, are rectangular pieces of polished steel of the following size & form.



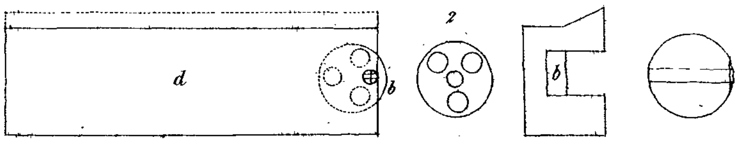
Transverse Section.

Enlarged View of Gold Stud

Breadth from a. to b. 0·5 inch
Length 0·8 inch

NEW CONTACT PIECES FOR RECTANGULAR TERMINATIONS OF END MEASURES.

Fig. 4.



(1) Plan of Contact pieces shewing small Spherical projection, actual size.

(2) Screw by which steel projection is attached to contact piece.

(3) Transverse Section of Contact pieces, also shewing steel projection b

(4) Enlarged View of Gold Studs on Contact pieces

Vincent Brooks Day & Son lith.

Appendix VII.—*continued.*

and the tenth 3–4, which is opposite the termination of the metre, has been subdivided into hundredths, in order to facilitate the comparison of the length of the metre with the imperial yard. In the comparisons made with these subdivided standard measures of length, these numbers are used to distinguish the several subdivisions.

Value of one division of each micrometer since ascertained.

The value of one division of micrometer No. 1, was determined provisionally, as follows:—

1868, June 17.—Mean temperature 67·64° Fahr.
Subdivided inch measure = 31493·6 div., or 1 div. - - - - - = 0·00003175 in.
Subdivided inch 36–37 of subdivided yard = 31526·4 div., or 1 div. - = 0·00003172 „
Mean 1 div. = 0·00003173 „

The value of micrometer No. 2 was in like manner determined at the same time from the first tenth of the divided inch, and the first three tenths of the same inch 36–37 of the divided yard,

Mean temperature 68° Fahr. 1 div. = 0·00003205.

The cobweb line of micrometer No. 1 requiring to be renewed by Messrs. Troughton and Simms, the value of one division was again taken,—

1868, January 12.—Mean temperature 57·5° Fahr.
By mean of two separate comparisons the divided inch = 31376·3 div., or 1 div. = 0·00003187 in.

The difference of temperature with that of the last comparison, in June 1868, is 10° Fahr., equal to a contraction of 0·0000947 inch, in the whole inch on a bronze bar. But this difference does not affect the last decimal figure in the value of one division as shown above, it amounting only to 0·000000003 inch.

A second determination of the value of one division of micrometer No. 2 was also taken, from the whole of the divided inch, the previous determination being made from one tenth only of the divided inch and three tenths of the subdivided inch of the divided yard,—

1868, January 13th.—Mean temperature 49° Fahr.
By mean of two separate comparisons, 1 inch = 31365 div., or 1 div. = 0·00003188 div.

The value of one division of micrometers 3 and 4 was determined by Mr. Chisholm and Mr. Chaney on 14th January 1869, from the first tenth, 0·1 of the divided inch. This is the only subdivided tenth of this divided inch, and no further measurement could be made from it, as the range of each of the micrometers 3 and 4 extends only to 0·05 inch. Micrometers 1 and 2 have each a range of 0·1 inch.

Mean temperature 51·5° Fahr.
Micrometer No. 3.—0·1 inch—
Mr. Chisholm = 3115·5 div.
Mr. Chaney = 3116·2 „
Mean = 3115·8 „ or 1 div. = 0·00003209 inch.

Micrometer No. 4.—0·1 inch—
Mr. Chisholm = 3220·0 „
Mr. Chaney = 3119·0 „
Mean = 3119·5 „ or 1 div. = 0·00003106 „

But it was considered more satisfactory to take the value of one division of these two micrometers from the whole of the inch 36–7, on the divided yard, each tenth of which is subdivided into hundredths of an inch. Each 0·05 of the inch was measured separately, the mean of three measurements being taken.

1868, January 19.
Micrometer No. 3.—Temp. 52·8° Fahr.—1 inch = 31,136·5 div., or 1 div. = 0·00003215 inch.
„ No. 4.—Temp. 53·5° Fahr.—1 inch = 31,001·0 div., or 1 div. = 0·00003225 inch.

These preliminary values of the four micrometers will be checked when the actual standard length of each inch and its subdivisions shall have been determined.

Decimal table of values of the divisions of each micrometer.

The following table has been found useful in calculating the difference in parts of an inch between two standards:—

Decimal Table of Values of the Divisions of each Micrometer.

No. of Divisions.	Value in Parts of an Inch.			
	No. 1 Microm.	No. 2 Microm.	No. 3 Microm.	No. 4 Microm.
1	0·00003187	0·00003188	0·00003215	0·00003225
2	0·00006374	0·00006376	0·00006430	0·00006450
3	0·00009561	0·00009564	0·00009645	0·00009675
4	0·00012748	0·00012752	0·00012860	0·00012900
5	0·00015935	0·00015940	0·00016075	0·00016125
6	0·00019122	0·00019128	0·00019290	0·00019350
7	0·00022309	0·00022316	0·00022505	0·00022575
8	0·00025496	0·00025504	0·00025720	0·00025800
9	0·00028683	0·00028692	0·00028935	0·00029025
10	0·00031870	0·00031880	0·00032150	0·00032250

Description of new contact apparatus.

The micrometrical comparing apparatus is constructed principally for the comparison of line standards, by observations of the fine defining lines through the microscope. To employ it for the comparison of end measures, a further arrangement was requisite, and for the purpose, a contact apparatus has been constructed by Messrs. Troughton and Simms.

The contact apparatus is shown in Plate 2 (Figs. 1 and 2), and the contact pieces, to which the apparatus is auxiliary, are seen separately in Figs. 3 and 4. This apparatus is made of brass, and is composed of two parts, A, B, of exactly similar construction, to be fitted respectively to each end of the bar to be compared. Tha principal part of the apparatus is supported on a brass cylinder *h*, *h*, Fig. 1, which fits into a strong clamp *i*, *i*, closed by the screws *k*, *k*, and can be thus raised or lowered. This clamp is attached to a base plate *l*, *l*, by screws, which also serve to adjust the contact apparatus to a horizontal plane. On the top of the cylinder are fitted two sliding pieces (*e*, *f*, Fig. 2) moving in directions at right angles to each other. The screws *e′*, *f′*, give the required motion to these sliding pieces. The under sliding piece (*f*) works in a bevilled groove cut in the top of the cylinder, and serves to move the contact pieces (*a*, *b*) in the direction of the bar (*m*, *m*, Fig. 2) to be compared. The upper sliding piece (*e*) is fitted into a bevilled groove on the upper surface of the under sliding piece, and can be used in adjusting the contact piece (*a*, *b*) laterally. Figs. 1 and 2 show a bar under comparison (*m*, *m*, Figs. 1 and 2) placed in position and supported by lever frames, part of one of which is seen, C (Fig. 1). The two contact pieces (*a*, *b*) are also shown, supported by the contact apparatus (A, B), and pressed against the spherical ends of the bar (*m*, *m*). By means of the fine lines cut on the contact pieces *a*, *b* (Fig. 3) the bar (*m*, *m*) which is an end measure (à bouts) has been converted into a line measure (à traits).—[*See plan.*]

Contact pieces for spherical terminations.

The two contact pieces *a*, *b*, used for end measures with spherical terminations, are rectangular pieces of polished steel. They are shown separately in Fig. 3.

Each fits into a bed formed by two springs (*c*, *c′*, Fig. 2) and a strip of grooved brass (*g*, *g*, Fig. 1) attached to the upper sliding piece of the contact apparatus. The two springs (*c*, *c′*) keep the contact piece in position; one spring, regulated by a screw, moves the contact piece forward in the direction of the bar, the other spring presses against the side of the contact piece and prevents it shifting laterally. The strip of brass (*g*, *g*), which form the third side of the bed into which the contact piece fits, is bevilled, to correspond with the bevilled side (*c*, Fig. 3) of the piece. *a′ b′* is the line of contact to the extremity of an end measure, parallel and close to which a very fine line is cut between two other fine longitudinal lines, upon a gold stud, to be used as a measuring line. By ascertaining the exact distance between this measuring line and the line of contact *a′ b′* in each of the contact pieces, an accurate comparison between a line standard and an end standard can readily be made by means of the microscopes, all that is required after completing the observations being, so far as regards the end standard, to deduct the sum of the two measuring distances on the contact pieces thus ascertained.

Appendix VII.—*continued.*

Verification of contact pieces for spherical terminations.

Verification of Measuring Distances on Contact Pieces a and b.

Date.	Number of Readings.	Result of Comparisons.	
1868.			Inches.
March 18 - -	40	Mean measuring distance of contact piece - - -	a=340·75, or 0·01086311
„ - -	40	„ „ „ - - -	b=290·60 „ 0·00926433
		Total - - -	631·35 „ 0·02012744
„ 19 - -	40	Total distance between defining lines of a and b - -	632·50 „ 0·02016410
„ - -	40	„ „ „ - - -	631·33 „ 0·02012690
		Mean - - -	631·91 „ 0·02014554

In making the comparisons, the two contact pieces were placed together, and the distance taken first between each measuring line and the middle of the line of contact, and then between the two measuring lines. The breadth of the line of contact between the two pieces was apparently exactly equal to the thickness of one of the cobwebs of the microscope. The distance between the two defining lines of the contact pieces a and b, when placed in juxtaposition, was thus determined to be 631·91 divisions of micrometer No. 2, or 0·02014554 inch.

New contact pieces for rectangular terminations.

But these contact pieces with rectangular terminations are not suitable for the comparison of end measures having rectangular terminations, for which spherical contact pieces are required. Two new contact pieces (c and d, Fig. 4, Plate 2,) have consequently been furnished, which can be fitted to and used with the contact apparatus.

The new contact pieces, which were specially provided for the comparison of the Royal Society's platinum mètre à bouts, are also rectangular in shape, of the size (a) shown in Fig. 4, viz., 2 in. long, ½ in. broad, ⅜ in. deep. They are of gun metal instead of steel, and are brought into contact with the end of a bar or measure à bouts by small steel spherical projections (b) so constructed as to fit in between the " burr " or rough edges of the mètre à bouts.

Comparison of Measuring Distances on New Contact Pieces, c and d.

Their verification.

This comparison was made with micrometer No. 2, the spherical ends of the new contact pieces being placed in juxtaposition. The total distance between the two defining lines c and d was taken, as the distance between each defining line and the spherical termination of the contact pieces could not be determined, in consequence of their not being at the same focal distance of the microscope. From the mean of 20 readings, the discharge between the two defining lines was found to be 3112·7 divisions of the micrometer, or =0·099232876 inch.

Official directions for comparisons with the microscopic apparatus.

The following official directions have been given by the Warden for the Departmental comparisons of standard measures of length with the microscopic apparatus:—

Directions for Comparisons with the Microsopic Apparatus.

Arrangement of Standard Bars.

The bars are to be placed in position under the microscope the day before the comparison is made, and are to be adjusted to the focus of the microscopes.

In placing the bars under the microscopes, the comparing standard should have the defining lines in the middle of the field of each of the two microscopes used, and the defining lines of the compared standard should always be *apparently* to the left of the crossing of the cobwebs lines. As the objects under the microscopes are reversed, under the left-hand microscope (No. 1) the compared will be always longer than the comparing standard or +, and under the right-hand microscope (No. 2) it will always be shorter than the comparing standard, or—

These directions are applicable both to the comparison of line standard measures, and to end standards with the contact pieces adjusted to them.

Adjustment of Position of Microscopes.

Before using the microscopes, care must be taken, by turning the spirit levels round to see that the axis of rotation of the two microscopes are vertical.

Noting of Temperature.

In comparing two bars of similar metal, it is sufficient merely to note the temperature of the room before beginning the observations. When the bars are of different metals, and generally when comparisons require correction for temperature, the temperature of the bars is to be taken, at the beginning and at the end of the several observations, by the mean of two thermometers placed upon the two bars under comparison.

Mode of Comparisons.

When line standard measures are to be compared the cross or the parallel cobwebs attached to each micrometer are first adjusted to the defining lines of the comparing standard. The bar or measure to be compared is then brought under the microscopes, and so placed that its defining lines appear through each microscope to be to the right of the micrometer cobwebs which have remained stationary, thus—

the cross lines represent the cobwebs, and the single straight lines the defining lines of the bar. This preliminary adjustment should be made the day before the comparison.

In comparing two bars, the cross cobwebs of microscope No. 1 (or the parallel cobwebs) are to be adjusted to the defining lines of the comparing standard, in order to note the number of the divisions of the micrometer; this is to be repeated twice, each time moving the micrometer screw. The same process is to be gone through with microscope No. 2; and then both processes are to be repeated with the defining lines of the compared standard. The mean difference in divisions between the two standards will be that between + difference of the mean of the first and third processes, compared with the — difference between the second and fourth processes, and the 12 readings will thus constitute one observation. It is found by experience that the first observation is not entirely to be depended on, and it is to be discarded. Three more observations are to be made, and the mean result to be taken as the difference in divisions between the two standard measures under comparison. The difference between the two standards in decimal parts of an inch is found by a computation from the value of a division of each micrometer.

In using the micrometer, special care must be taken always to turn the screw *in the same direction* (viz., from 0 to 100), when the actual adjustment of the cobwebs to the defining line is being made.

Mode of Noting Comparisons.

The comparing standard being brought in position under the microscopes, three separate adjustments are to be made with the micrometer at the left-hand and at

Appendix VII.—*continued.*

the right-hand microscopes, and the readings noted, the mean of each three readings being taken as the definite result of one observation. The bar to be compared is next brought under the microscopes and its difference from the standard ascertained by adjusting the cross micrometer cobwebs to each defining line of the bar, the mean of the readings of the three such adjustments being taken as before as the actual result of one observation.

As the defining lines of the bar under comparison appear through the microscope to the right of the micrometer cobwebs, the actual position being reversed, the readings of the left-hand micrometer will indicate that the bar is too long, while those of the right-hand micrometer will indicate that the bar is too short as compared with the standard; consequently, the readings of the left-hand micrometer must have the sign + placed before them, the sign — being placed before the readings of the right-hand micrometer.

Form of recording comparisons.

The following example shows the form of thus noting comparisons of standard measures of length:—

Date of Comparison.	Temperature.	Compared Standard.	Comparing Standard.	Results.	
				In Divisions.	In Inches.
1869, April 26 - -	—	Kater's yard No. 1 with gold points= - - Next observer.	Generator, bronze yard No. 6 - - -	−54·42	−0·00173

	Readings of No. 1 Microscope.		Compared +			Readings of No. 2 Microscope.		Compared—		Difference of Compared.
	1. Comparing.	4. Compared.				2. Comparing.	3. Compared.			
	div.	div.	div.	div.		div.	div.	div.	div.	div.
2·54 P.M.	45·8 45·4 45·9	62·0 63·0 61·0				83·0 83·2 83·8	151·9 151·4 150·1			
	137·1	186·0	49·8	16·3		250·0	453·4	203·4	67·8	−51·5
3· „	48·3 47·5 48·1	60·4 61·1 60·9				84·0 85·0 84·9	150·1 150·4 151·5			
	143·9	182·4	38·5	12·83		253·9	452·0	198·1	66·03	−53·2
3·6 „	47·6 46·6 46·2	62·5 62·6 63·4				84·2 85·0 85·6	156·1 155·5 154·4			
	140·4	188·5	48·1	16·03		254·8	466·0	211·2	70·4	−54·36
3·12 „	49·0 50·4 50·2	60·0 60·0 61·8				86·8 85·0 86·4	153·0 152·6 152·9			
3·18 „	149·6	182·8	33·2	11·06		258·2	458·5	200·3	66·76	−55·7
				39·93					203·20	163·26
				13·31					67·73	−54·42

1 Division of Micrometer, No. 1=0·00003187 inch.
13·31
3187
9561
9561
3187
+0·0004241897 inch.

1 Division of Micrometer, No. 2=0·00003188 inch.
67·73
9564
22316
22316
19128
—0·0021592324 inch.
+0·00042

∴ Compared Standard−0·00173 inch.

Re-verification of Official Standard Yard of 1825.

Re-verification of official standard yard, of 1825.

The comparison of the official standard yard of 1825 (O) was made on 9th July 1868, with the bronze line standard yard No. 6 (B), the most accurate of all the copies of the imperial standard, its standard temperature being exactly the same as that of the standard, 62° Fahr. The two contact pieces, *a* and *b*, were fixed by elastic bands inside the upright steel terminations of O, and the following comparisons were made with the microscopical apparatus.

Comparison of Official Standard Yard of 1825 (O), *with bronze line Standard No.* 6 (B).

Obs. 1.	The line of contact being adjusted by micrometer No. 2 to the defining line of *b*, it was found by No. 1 - -	B=O+45 div.
Obs. 2.	When similarly adjusted by No. 1, it was found by No. 2 - -	B=O+44 „
	Mean	B=O+44·5 div.

Appendix VII.—*continued.*

Obs. 3. By similar comparisons of defining lines of contact pieces by No. 1 - B=O + 698·5
Obs. 4. By similar comparisons of defining lines of contact pieces by No. 2 - B=O + 696·25

Mean B=O + 697·4

Obs. 5. From defining line of contact piece *a* to contact, by micrometer No 1. - =348·9
Obs. 6. From defining line of contact piece *b* to contact, by micrometer No. 2 - =306·8
Deduct - ——— 655·7

Whence - B=O +41·7 div.

Mean result - B=O +43·1 „
Mean value of 1 div. of micrometers No. 1 and No. 2 - =0·000031875 in.
Whence - B=O +0·001374 in.
or the official standard yard is found to be 0·001374 inch less than the standard, and =35·998626 inches.

This measurement differs little from a former computation of the length of the Exchequer standard yard mentioned in p. 61 of the Astronomer Royal's account of the construction of the new national standard of length, in the terms of which the Exchequer yard is stated to have been ≐ 35·994451 inches.

It should be observed that the distance between defining lines and contact of *a* and *b*, exceeds that stated at p. 99, when these contact pieces were placed together by using the contact apparatus. But as this apparatus could not be used with the defining ends of the official standard yard, nor so good a contact obtained, another determination of the distance appeared to be required in this instance.

Length of ancient standard yards, in terms of new imperial standard.

It may be interesting here to state the length of the more ancient standard yards in terms of the imperial standard, as mentioned in the same page of Mr. Airy's account. These old standards are all of brass.

Queen Elizabeth's standard yard	-	=35·989764 inches.
Henry 7th's „	-	=35·962720 „
The old Tower yard, adopted in 1742–3 by the Royal Society as more accurate than the Exchequer standard (Airy, p. 42)	-	=36·001907 „

These are the oldest standard yards known to exist, and it is thus shown that the length of the legal yard in this kingdom has not appreciably varied for all commercial purposes since the earliest periods at which its actual length can be satisfactorily ascertained.

Description of Kater's four standard yards, with gold points. Phil. Trans. 1826, p. 42.

The official standard yard is described by Captain Kater as intended merely for the purpose of sizing yards employed in commerce. At the desire of the Commissioners of Weights and Measures, four other standard yards with gold pins bearing points were constructed by Dollond, under Kater's superintendence, "to be carefully preserved and transmitted to posterity "for the purpose of being referred to upon extraordinary "occasions, or upon questions important to science."

These four standard yards are stated by Kater to have been deposited at the Exchequer, and at the Guildhall London, Edinburgh, and Dublin respectively. In point of fact, only the four yards with steel terminations were so deposited. The four yards with gold points were left by Captain Kater at the Treasury, and do not appear to have come under the observation of the Commissioners for restoring the Standards, appointed in 1843, although their construction is referred to in Mr. Airy's account, p. 6. They were transferred to the Standards Department in 1865, no comparisons of them having been made since their original deposit by Kater in 1825.

Captain Kater adjusted these four standard yards by Shuckburgh's scale, "so that no perceptible error re- "mained." The bars are of brass and of the same thickness as that scale, being 1¼ in. wide and ½ in. thick, and they are about 38½ in. long. At 1¼ inch from each extremity a hole was drilled about $\frac{1}{10}$ in. in diameter, and being made slightly conical by being enlarged from the under surface, a plug of brass was ground into the the hole so as to fit it perfectly. A gold disk was let into the top of each plug, and reduced to a level with the surface of the scale. A very fine deep dot was then made by Mr. Dolland upon each of the gold disks, and the length of the yard is the distance between the two dots on the disks. The right-hand plug was made to project beneath the bar, and had a small hole through it to admit a wire, by means of which it might be turned round. The dot upon this moveable disk not being exactly in its centre, it was susceptible of adjustment. When adjusted the plug was reduced to a level with the under surface of the bar.

After the four yards were adjusted, Kater again compared them by means of his microscopical apparatus with the Shuckburgh scale. The bars were placed upon a table and were all found apparently too short. The error, amounting to 0·0016 inch, was proved to be caused by the inequalities of the surface of the table, the upper and under surfaces of the bars being in different states, one being compressed and the other extended. It was consequently determined to make the measuring plane midway between the two surfaces. The thickness of each bar was reduced at its extremities one half, and the gold disks being reinstated, the adjustment of the points was completed as before. After this adjustment Kater repeatedly compared the four standard yards with Shuckburgh scale, and no perceptible error could be detected.

Kater's method of thus taking the measuring place midway between the upper and under surfaces of the bar has been followed in all the standards yards constructed under the superintendence of the Commissioners of 1843 for restoring the Standards. Instead, however, of reducing the thickness of the bar at the extremities, and thus weakening the bars, the defining lines are cut at the bottom of a cylindrical hole drilled down to half the depth of the bar. The additional precaution has been taken of supporting the bar upon two brass lever frames, each having four rollers arranged at such intervals so as to exert equal pressures upwards, the bars are made stiff enough to be supported without flexure upon the few points at which the rollers are applied; they are all about 1 inch square in section.

The four standard yards with gold points are kept in mahogany boxes in which they are fitted. Each box has two Bramah locks. The bars are engraved on the upper surface,—

Dollond, London. IMPERIAL STANDARD YARD. 1824: Fahrenheit 62°.
Adjusted by Captain Henry Kater, F.R.S.

They are distinguished from each other by slight marks, I, II, III, IV, on the right-hand extremity of each bar.

Their r verifica with th imperia standar yard.

These four standards yards have now been compared with the bronze line standard yard No. 6 (B.) and with each other. The temperature of the air in the comparing room averaged about 62° Fahr. during the comparisons, not varying more than 3° higher and lower. As the average rate of expansion for brass and bronze is very nearly alike, being for 1° Fahr. 0·000344 and 0·000341 inch respectively in 36 inches, it is evident that any correction for temperature could affect only the 6th place of decimals and may be disregarded. The results of the comparisons are as follows:—

Kater's Standard yard with gold points, - - -
No. 1=35·998278 inches.
No. 2=35·998386 „
No. 3=35·998663 „
No. 4=35·997943 „

Mean length - - =35·998318 „

But the mode of defining the Standard length upon a metallic bar by a gold point makes its accurate determination by means of a microscopical comparing apparatus difficult, if not impossible. In this important respect, a line standard, or an end standard is much to be preferred. It will be seen that the standard length of the official standard yard, constructed by Kater at the same period as the four yards with gold points approximates very closely to their mean length.

Re-verification of Line Standard Yard, Bronze, No. 6.

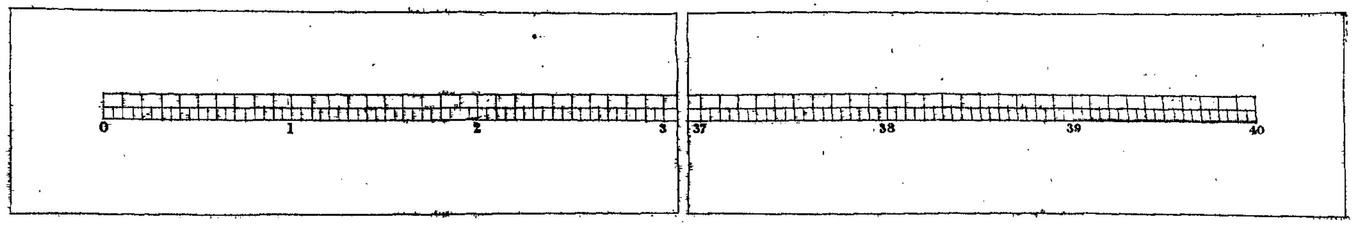
Re-veri tion of standar yard, br No. 6.

Considering the doubts which have been expressed of the constancy of the length of a standard bar at its standard temperature, after the lapse of a number of

To face page 703.

Plate 3.

FLAT BRASS SCALE, N°48.



N° 48. Standard Yard at 62°·00 Faht.

Length of Bar = 41 inches
Breadth " $1\frac{1}{2}$ "
Thickness " $\frac{5}{12}$ "

The Scale is divided into 40 inches. The inches from 0 – 39 divided into tenths & twentieths; the inch from 39 40 divided into tenths, twentieths & hundreths.

Appendix VII.—*continued.*

years, it may be thought important to reverify with the imperial standard, the one standard bar described as bronze 28, or later as No. 6, the length of which was found by Mr. Sheepshanks in 1855 to be so nearly identical with the standard as to have the same standard temperature assigned to it. At p. 59 of the Astronomer Royal's account of the construction of the new national standard of length, it is shown that bronze 28=the new imperial standard+0·03 div. or 0·000001074 inches. The following comparisons have therefore been made with micrometer No. 1=0·00003187 inch, and No. 2=0·00003188 inch.

Comparison of Bronze Bar No. 6 with the Imperial Standard. (IS).

Date of Comparison.	Number of Readings.	Results of Comparisons.		Remarks.
		Div.	Mean.	
1869, March 25 - -	36	No. 6=IS−1·11	−1·106 in.	IS nearest to lamps and observer.
„ „ 30 - -	36	No. 6=IS−0·92		
„ „ 31 - -	36	No. 6=IS+0·77	+1·055 „	No. 6 nearest to lamps and observer.
„ April 2 - -	36	No. 6=IS+1·33		
	144			
Mean of readings -		No. 6=IS +0·038 div. or 0·000001209 in.		

This result is very satisfactory. *It may therefore be considered that the two standards are still identical in length, and it may also be assumed that no appreciable difference in their length has occurred in the 14 years which have elapsed since the original comparison.*

Re-verification of Flat Brass Scale No. 48.

When received at this Department this brass scale was not protected by being placed in a separate case; and it was not only much oxidized, but had evidently received some damage, as there were several dents upon the metal. It has now been cleaned.

Comparison of flat brass scale.

The yard denoted by the length of 0—36 inches on the flat brass scale No. 48, and the standard yard bronze No. 6, are both accurately verified standard measures of a yard at 62° Fahr., the difference of thermometric expansion being 0·000009 in. for 1° Fahr.; brass No. 48, expanding 0·000350 in. (Airy, p. 21), and bronze No. 6, 0·000341 in. (Airy, p. 61).

From the following drawing and description of brass No. 48 it will be seen that this scale is divided into 40 inches. The length 0—36 in. is that part of the scale which has now been compared with bronze No. 6.—[*See* Plate 3.]

The flat brass scale was delivered to the Standards Department on 30 July 1867 by the Astronomer Royal, and it is stated by him in his account of the construction of the imperial yard to have been found almost exactly equal to bronze No. 6, both measures being nearly identical with the imperial standard at 62° Fahr. The exact difference between the two measures was found by Mr. Sheepshanks in 1851 to be, flat brass scale No. 48=bronze No. 6—0·12 div. or 0·0000043 inch.

The defining lines on the scale are evenly cut, but appear very broad under the microscope, their breadth being nearly 50 divisions of the micrometer. It has consequently been thought advisable to compare the brass scale with bronze No. 6, as follows:—1. The distance from the *middle* of the defining line (0) to the *middle* of (36); 2. from the *outside* of (0) to the *outside* of (36); 3. from the *inside* of (0) to the *inside* of (36); the inside of the line being that side nearest to the middle of the scale; 4. a second comparison taken from the middle of each line; in comparisons 1 and 4, the relative positions of the bars were changed so that each in turn was next to the observer.

Comparisons of Flat Brass Scale No. 48 with Bronze No. 6.

No.	Date of Comparison.	Number of Observations.	Temperature.	Results of Comparisons.			
	1869.				Div.	Div.	Inch.
1	April 8 -	9	47°·9 Fahr. -	Brass scale No. 48=Bronze No. 6 -	-	+11·63 or	+0·00037059
2	„ „ -	10	47·5 „ -	„ „ „	+43·75	+11·19 or	+0·00035651
3	„ „ -	10	47·4 „ -	„ „ „	−21·37		
4	„ 9 -	9	48·2 „ -	„ „ „ -	-	+10·63 or	+0·00033848
				Mean -	-	+11·15 or	+0·00035519
				Deduct excess of expansion for 14° (48°−62°) of brass scale No. 48, at 0·000009 in. for 1° Fahr. - - - - - -			0·000126
				∴ Flat brass scale No. 48=bronze No. 6 at 62° Fahr. - - -			+0·00022919

It would appear from this determination that the standard temperature of the brass scale No. 48, is no longer 62°, but 61·35° Fahr.

Verification of the length of the yard on the new subdivided standard bar.

Verification of yard on new subdivided standard bar.

The length of the yard marked on the new subdivided standard measure of length (SS) was first verified by comparison with the line standard yard No. 6, the standard temperature of which is 62°, and which has been determined to be exactly equal to the imperial standard. Both these bars being of Baily's metal, no correction is required for temperature.

The following COMPARISONS were made with microscopes No. 1 and No. 2—

Mean value of 1 div. of micrometer =0·000031875 inch.

Comparison of SS. with Bronze Yard No. 6.

No.	Date of Comparison.	Mean Temperature.	Number of Readings.	Result of Observations.
	1868.			
(1)	June 24 - -	67°·28 Fahr. -	32	SS=No. 6−5·8125 div.
(2)	„ 27 - -	67·75 „ -	32	SS=No. 6−6·0125 „
(3)	July 2 - -	67·18 „ -	32	SS=No. 6−4·66075 „
(4)	„ 14 - -	71·3 „ -	16	SS=No. 6−5·65 „
		Mean of	112	SS=No. 6−5·53394 „
				∴ SS=No. 6−0·00017639 inch.

Appendix VII.—*continued.*

As bronze expands 0·000341 inch for 1° Fahr., it follows from this result that the standard temperature of SS is 62·52° F.

But since the period of this comparison SS was returned to Messrs. Troughton and Simms in order that some further subdivisions and small figures denoting the several lengths might be engraved upon it, after which it was considered requisite that a further comparison should be made.

Further Comparison of SS. with Bronze Yard No. 6,

No.	Date of Comparison.	Mean Temperature.	Number of Readings.	Result.
	1869.			in.
(5)	Aug. 21 - - -	64°·4 Fahr. -	36	SS=Bronze No. 6—2°·93 or 0·00009398
(6)	Sept. 2 - - -	67·0 „ -	36	SS=Bronze No. 6—2·72 or 0·00008701

Mean SS=Bronze No. 6—0·00009050 in.
or SS=Imperial Yard at 62·27° F.

New commercial standard measure of length CS.

In the Report of the Standards Commission of 1841, § 51, an opinion is expressed that the method of comparing at the Exchequer the measures of length does not appear sufficiently good, as it gives no means of determining the amount of error of the measure compared.

A new commercial standard of length, being a bar with the length of a subdivided yard, and subdivided metre marked upon it, has accordingly been constructed under the direction of the Commission by Messrs. Troughton and Simms, with a convenient comparing apparatus attached to it, to be used in the official comparison of the local standard measures of length, instead of the official standard yard of 1824, which has been employed since this period for verifying the local standard yards used by inspectors of weights.

DESCRIPTION of the NEW COMMERCIAL STANDARD of IMPERIAL and METRIC LENGTH, CS, with its COMPARING APPARATUS.

Its description.

The iron frame upon which the standard bar CS rests is composed of two cast-iron uprights A, A, (see Fig. 1, Plate 4) screwed to a base plate B, and a cross tie C; D, D, are two steel lever frames each having two steel rollers for supporting the bar CS. Each of these two lever-frames oscillates by means of a steel axis moving in a gun metal groove fixed on the top of each of the uprights A, A. A strong steel pin rises from the middle of the cross tie C, and fits into a circular hole on the under side of CS, to keep this standard bar in its proper position and prevent lateral shifting.

The standard measuring bar CS, the cross vertical section of which is shown of the actual size in Fig. 3, is of Baily's metal, 1¾ inch broad on the upper surface, 2·625 in. thick, and 49⅜ inches in length. Upon the left-hand end (see Fig. 2) the steel terminal plate EG, is securely fixed with four screws and steady pins. This terminal plate is half an inch thick, and projects on each side of the Standard bar, having two measuring plane surfaces at right angles to the axis of the bar, and 3 inches wide. The corresponding steel terminal plates F, H, are similarly fixed to the brass frame I, which is constructed to slide along the standard bar CS.

This frame, which is 9 inches long and 3⅛ in. broad, carries two verniers with two separate scales of 50 divisions each, for subdividing the smallest imperial or metric measure marked upon the bar.

At the left hand end of the scales marked upon CS, the words "Troughton and Simms, London, 1869," are engraved; and at the right-hand end of the metric scale "Metre, at 32° Fah.," and of the imperial scale after the word inches, "at 62° Fah. Standard."

The scale of imperial measure is marked upon CS, in inches and twentieths of an inch from 6 inches to 43 inches. The complementary length of the first 6 inches is made up by the distance from the line marked 6 inches on the scale to the rectangular plane E $=2\frac{15}{20}$ in., and from the rectangular plane F to the line O on the vernier of the imperial scale $= 3\frac{5}{20}$ in. Thus, when the length between the two rectangular planes E and F, intended for the comparison of end measures, or measures à bouts, is exactly 36 inches, the line O of the vernier of the imperial scale coincides with the line of 36 inches on the standard bar CS.

For comparing end measures with upright terminations or bed measures, such as the official standard yard constructed by Kater and all the copies now used as local standard yards by inspectors of weights and measures, the two rectangular planes G and H are used. The length from the line marked 6 inches on the scale to G, is 5·5 inches, and from H to the line O on the vernier 0·5 inch.

The scale of metric measure is marked upon CS in centimetres and millimetres, from 15 cm. to 1 metre, and is further continued for the length of 18 cm. For the measurement of end measures, the complementary length of the first 15 cm. is made up by the distance from the line marked 15 cm. on the scale to E =6·8 cm., and from F to O on the vernier metric scale =8·2 cm. For bed measures, the same complementary length is made up by the distance from the line 15 cm. to G =13·8 cm., and from H to O =1·2 cm.

The mode in which the two scales of imperial and metric length are marked upon the standard bar CS, may be seen from Fig. 4, showing part of the upper surface of CS, with the ends of the two scales, of the exact size.

Over the vernier scale is an adjustable magnifying eye piece, carrying a reflector, and moveable along a brass bar, for reading the fine lines of the scale. It will thus be seen that the length of imperial measures is read off to 0·001 inch, and of metric measures to 0·02 millimetre, and half of these minute distances may be easily read off by estimation.

The pressure of the rectangular planes E, F, and G, H, against the defining ends of the measuring bar under comparison is effected by means of the steel screw K working in a brass nut fixed upon the frame I. The shank of this screw is supported upon and turns in a collar of the second brass sliding frame L, which is also constructed to move together with I, along the standard bar CS, and both can be fixed with a screw. Above the collar of L two strong springs are placed, against each of which a collar on the shank of the screw K presses. One collar is constructed to act against its spring in the comparison of end measures; the other, which acts in the contrary direction, in the comparison of bed measures. The spring yields only after a determinate pressure of the rectangular planes E, F, or G, H, against the ends of the compared measuring bar. The pressure of the screw then acts against the spring only, and is taken off from the brass frame I carrying the vernier scale, which no longer moves.

There are two distinct supporting frames for end measures and bed measures respectively, upon which they can be properly placed for comparison. These two supporting frames are precisely similar, and are on either side of the frame of the standard bar CS. The upper parts of these two supporting frames are shown in Fig. 2, and it may be sufficient to describe one of them, as seen in section in Fig. 1.

The mahogany slab M, 48 inches long, 5¼ in. broad, and $1\frac{1}{10}$ in. thick, supports the two steel lever frames carrying rollers, upon which the measuring bar under comparison is placed exactly parallel to the standard bar CS. The slab rests upon and is firmly secured to a strong iron plate N, which can be moved horizontally upon the iron plate P, having bevilled edges, by means of a strong screw and winch handle, either towards or from the standard bar frame.

The plate P is firmly fixed upon a thick iron rod ending in a screw, which works in a nut turning in a collar on the top of the iron support Q, also firmly screwed to

NEW COMMERCIAL STANDARD OF IMPERIAL AND METRIC LENGTH, WITH COMPARING APPARATUS.

Plate 4.

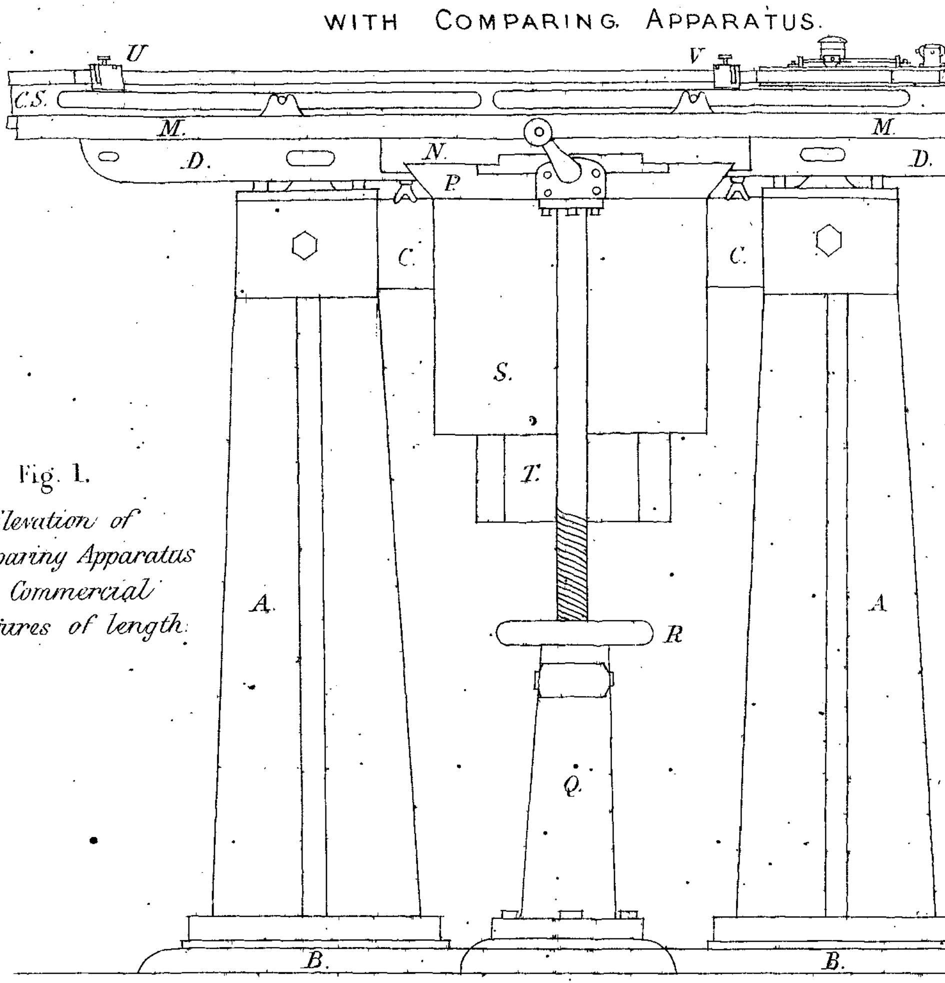

U
V
K
L
C.S.
C.S.
M.
M.
D.
D.
N.
P.
C.
C.
S.
T.
A.
A.
R
Q.
B.
B.

Fig. 1.
Elevation of Comparing Apparatus for Commercial measures of length.

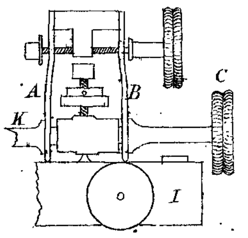


Fig. 5
Elevation shewing the regulating action of the springs on the screw K.

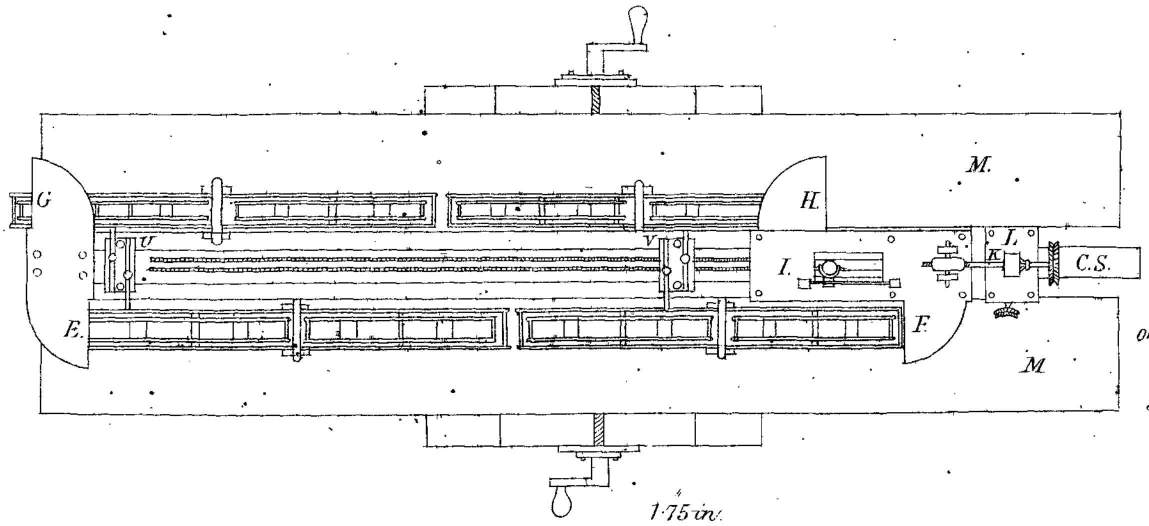

G
H
M.
U
V
I.
L
K
C.S.
E.
F.
M

Fig. 2.
Plan of upper part of comparing apparatus & standard bar.

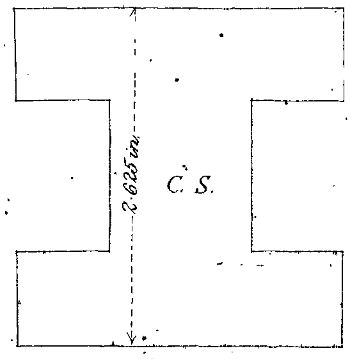
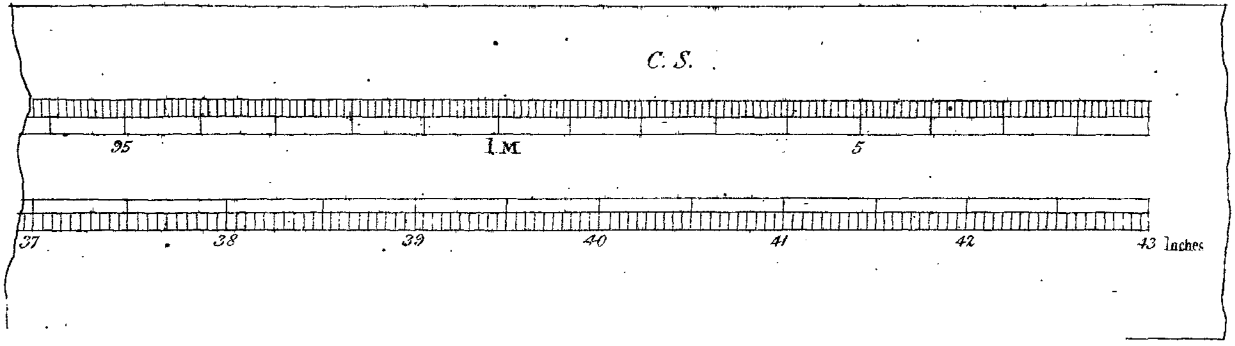

1·75 in.
2·625 in.
C. S.

Fig 3.
Cross Section of Standard bar Full Size

Fig. 4 *Portion of upper surface of standard bar. Full Size.*


C. S.
95
1 M
5
37
38
39
40
41
42
43 Inches

Appendix VII.—*continued.*

the base plate B. By turning round the rim R of this nut the measuring bar under comparison, supported on the slab M, is raised to the requisite level in relation to that of the comparing standard bar CS. In order to secure that the whole of the supporting frame is raised in a vertical line, an iron plate S is fixed to the under side of P and slides upon a bevil of the iron plate T, which is a part of the cross tie C, being cast with it.

For the purpose of placing a compared bar under comparison exactly parallel to CS, this standard bar carries two sliding gauges U and V, each having upon its upper surface two small sliding graduated steel slips, for guaging the distance between CS and the compared bar. The two outer slips are intended for bed measures under comparison, and the two inner slips for end measures. The sliding guages U and V, and the four sliding slips, are fixable with screws.

Thus, by means of this standard measuring bar and comparing apparatus, not only can any end or bed measure of a yard or metre be accurately compared, but any corresponding line measure, and any intermediate subdivisions can also be verified by comparison with the standard CS. It is only necessary to make the rectangular planes E, F, or G, H, exactly coincide with the two defining lines of the required measure upon the compared bar, and to observe, whether there is any difference between the line O of the vernier and the corresponding line on the standard bar CS.

Its preliminary verification and adoption for departmental use.

The following official minute which was laid before the commissioners at their meeting on 3rd December 1869, and approved by them, records the delivery at the department of the new commercial standard of length and the comparing apparatus, the verification of the length of the yard marked upon it, its adoption for for departmental comparison instead of the official standard yard of 1824.

Minute, 3rd December 1869.

Official Minute, 3 Dec. 1869.

Messrs. Troughton and Simms having delivered at this department on 10th November, the new commercial standard of length, with a subdivided yard and metre marked upon it, and having a convenient comparing apparatus attached with verniers by which a difference of 0·001 inch, or 0·01 millimetre can be read, it has been temporarily placed in the weighing room No. 16, and a preliminary comparison of the length of the yard marked upon, it has this day been made by the Warden and Mr. Chaney by comparing it with the end standard yard, Bronze No. 69, determined to be 0·000112 inch more than the Imperial standard, and the official standard yard of 1824 which has been determined to be 0·001374 inch less than the Imperial standard.

The yard upon the new standard was found not to differ sensibly from No. 69, whilst it exceeded the official yard of 1824 by a little more than 0·001 inch. This preliminary comparison was consequently found to be satisfactory.

The Warden approves of the verification of the three copies of the standard yard for New Zealand by comparison with the yard marked upon the new commercial yard, and he directs that this new commercial standard measure of length to be distinguished as CS be used in future as the official standard for comparisons of copies of the standard yard, whilst the official standard yard of 1824 shall be used only for checking the comparisons made with the new standard. The use of the rod with handles is to be discontinued.

H. W. Chisholm,
Warden of the Standards.

Completion and fixing of comparing apparatus.

The comparing apparatus and standard were subsequently moved to room No. 18 adjoining the gas measuring room, and there more permanently fixed, the side GH for bed measures being towards the light, and EF for end measures being the side next the observer towards the fire-place. Some slight alterations were required to be made, including the arrangement and fixing of the roller frames for the standard bars under comparison which were not finally completed till 28 March.

Definite verification of new commercial standard yard.

On 17 March a further comparison of the length of the yard, marked 36 inches on the standard bar was made with the bronze end standard bar No. 69, by the Warden and Mr. Chaney. No sensible difference between them could be found. The verification of this standard yard measure was thus considered to be completed.

Directions for using the comparing apparatus.

The following official directions have been given for making comparisons with the new commercial standard of length.

Directions for using the New Comparing Apparatus for Measures of Length.

The compared yard is always to remain in the comparing room with the standard for 24 hours before the comparison, in order that the temperature of the bars may be equalized.

If there is a fire in the room, a screen should be interposed between it and the comparing apparatus.

In the comparison of both end and bed measures, the compared measure is to be placed in position on the rollers with one end in contact with the rectangular plane E or G, when the plane F or H is to be brought slightly into contact with the other end of the measuring bar by moving the frame I, which is then to be fixed by its screw.

Care must be taken that the defining ends of the compared bar are of the same height as those of the standard, and are placed opposite the middle of each rectangular plane, and that the two bars are exactly paralled as shown by the gauges U and V.

The two springs A and B which regulate the action of the screw K (See Fig. 5, Plate 4*) may both be left free. But it is particularly requisite that A be free for the comparison of end measures, and B for bed measures.

When an end measure is to be compared and has been placed in its proper position, the screw head C is to be turned *towards the observer until the vernier ceases to move*, and the screw acts only against the spring B, when the reading is to be noted, and if within the limit of tolerance, the measure is to be passed as correct, great attention must be paid so as not to overstrain the screw.

For the comparison of bed measures the same directions are to be observed, except that the screw head C is to be turned *away from the observer, and towards the bed measure* until the vernier ceases to move.

Standard Department, H. W. Chisholm,
25 March 1870. Warden.

Further verification of subdivisions of standard yard, &c. to be stated in subsequent paper.

The verification of the subdivisions of the Imperial yard, on both the new standard bars SS and CS, will be proceeded with as soon as the new measuring bar with a graduated slide marked with measures of a foot, and its subdivisions down to hundredths of inches, and of a decimetre with subdivisions down to millimetres now nearly completed by Messrs. Troughton and Simms is ready for use in the department.

The comparisons of all the subdivisions of a yard upon the several standard measures, will be reported in a continuation of this paper as well as the verification of the other new standards of length. The comparisons and verifications of all the metric measures of length upon the several standard bars will be stated in a separate paper.

Standard Department, H. W. Chisholm,
28 March 1870. Warden.

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* In *Fig. 5, in order to exhibit the action of the springs, the supporting side L is not shown.*

Appendix VII.—*continued.*

PAPER DELIVERED by the WARDEN OF THE STANDARDS.

PART II.—COMPLETION of VERIFICATION of STANDARD IMPERIAL MEASURES of LENGTH.

CONTENTS.

	Page
Verification of the subdivisions of the new standard yard SS. - - - - - - -	106
Distinction of the several defining lines - - -	„
Description of the graduated brass slider S. - -	„
Verification of the 3 feet marked on SS. - - -	„
Correction for difference of expansion of SS. and S. -	„
Actual comparison of 3 feet on SS. - - -	„
Verification of each length of four inches, 24–25 to 39–40	109
„ of each inch, 24–25 to 39–40 - - -	„
„ of each tenth and hundredth of inch, 36–37 -	110
Final determination of value of one division of each micrometer - - - - - - - -	116
Preliminary observations - - - - - -	„
View of field of microscopes and measuring rack - -	„
Value of a division at different parts of the micrometer screw and field of microscope - - - -	„
Observations for determining this value - - -	117
Results of these observations - - - -	119
Comparisons for finally determining value of one division of each micrometer - - - - -	„
Results of these comparisons - - - - -	„
Decimal table of value of divisions of each micrometer, in imperial and metric measure - - - -	120
Verification of twelfths of inch, 37–38 - - -	„
„ of eighths and sixteenths of inch, 38–39	121
„ of tenths of inch, 39–40, and hundredths of 39·3–39·4 - - - - -	122
„ of halves, quarters, eighths, and sixteenths, or nails, of yard, 0–36 inches - - -	123
„ of the divided inch, D. - - -	125

VERIFICATION OF THE SUBDIVISIONS OF STANDARD YARD, SS.

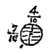
Verification of subdivisions of SS.

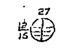
The subdivided scale of the standard yard marked upon SS. has been already described at p. 34 of Appendix II. to the Second Report of the Commission, and p. 5 of Paper XIX. The several subdivisions, the standard length of each of which have now been verified, are as follows:—

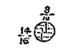
1. The 3 feet, viz., 1st foot, 0–12 inch.
   „ 2nd „ 12–24 „
   „ 3rd „ 24–36 „
2. The length of each 4 inches 24–28, 28–32, 32–36, and 36–40.
3. Each of the 12 inches of the 3rd foot, marked 24–36 (the 1st and 2nd foot are not subdivided into inches); and each of the four inches 36–40.
4. Tenths and hundredths of inch, 36–37
5. Twelfths of inch, 37–38.
6. Eighths and sixteenths of inch, 38–39.
7. Tenths of inch 39–40, and hundredths of the tenth 39·3–39·4.
8. Halves, quarters, eighths, and sixteenths, or nails, of the yard, 0–36 inch.

Distinction of the several defining lines.

The mode in which the defining lines of the several subdivisions of SS., from 0 to 36 inches, are cut upon gold studs is shown in the drawing at p. 34 of Appendix II. in the Second Report of the Commission, the stud of the 9th decimetre of the metre being there denoted of the actual size. It happens in two instances, viz., the defining lines of the 4th decimetre and of the 8th decimetre, that these approach so nearly to the lines of the 7th and 14th nail (or sixteenth of the yard) respectively, that they are cut upon the same gold stud; and this is also the case with the defining lines of the 12th nail and 27th inch, which are identical in length. The defining lines of the several measures are, however, easily distinguishable, as the two longitudinal lines, distant about 0·025 inch, between which the length is in each case to be taken, are distinct from each other, these lines for the decimetres being above those of the inches, and the lines of the sixteenths of the yard being below those of the inches; thus,







They can consequently be readily distinguished by their relative position to the longitudinal cobwebs of the microscopes.

Description of brass slider S.

For the purpose of more conveniently and satisfactorily ascertaining the standard length of the several subdivisions of standard measures of length, a graduated brass bar, made to slide along a groove in a bronze bar, has been constructed by Messrs. Troughton and Simms, and was delivered by them for the use of the department. This graduated brass slider S. is about 16 inches long, ½ inch broad, and nearly ¼ inch thick. *It moves or slides in a groove cut along the whole length of a bronze bar, similar* in form to the imperial standard yards, being about 40 inches long and one inch in cross section. S. has two graduated scales engraved upon it, one being an imperial scale of 13 inches, the other, underneath it, a metric scale of 11 centimetres in length. The brass slider S. is represented in Plate V. (*See opposite page.*)

The imperial scale consists of 1 foot, divided into inches, each inch being subdivided into tenths, which are distinguished by small figures engraved on the bar; the first inch, 0–1, being further subdivided into hundredths of an inch.

The metric scale consists of 1 decimetre, divided into centimetres, the first centimetre, 1–0, being further subdivided into millimetres.

All the lines are very finely cut, and the scale appears to be of Messrs. Troughton and Simms' best workmanship.

1. *Verification of the 3 feet on SS.*

Verificat
of the 3 f
marked c
SS.

The method adopted for the verification of each of the three feet marked on the Standard yard SS. is that employed by Mr. Baily in the verification of the Standard five feet scale of the Astronomical Society, in 1834, and described in his account of the comparisons, in the Memoirs of the Astronomical Society, Vol. IX., p. 98. This mode may be described by the following formula:—

The length of the yard SS being known,

$$x+y+z=\text{SS}; \text{ and } x=\frac{\text{SS}-(x-y)-(x-z.)}{3}$$

Each foot has been successively compared with the foot marked upon the graduated brass slide S., and by assuming the first foot as the zero of comparison, the difference between each foot marked upon SS. has thus been accurately ascertained. The standard length of SS. has already been determined as,

	in.	in.
At 62° F. SS.=1 yard	—0·00009050	or 35·99990950
At 62° 27, SS.=1 yard		or 36·00000000

Correct
for diffe
rence o
expans
of SS. a

The correction for the difference of expansion between the bronze bar SS. and the brass slider S. is very small, and the greatest difference during the several comparisons does not amount to one-third of a micrometer division. The thermometric expansion of 36 inches of bars of each metal for 1° F. have been thus determined by Mr. Sheepshanks:—

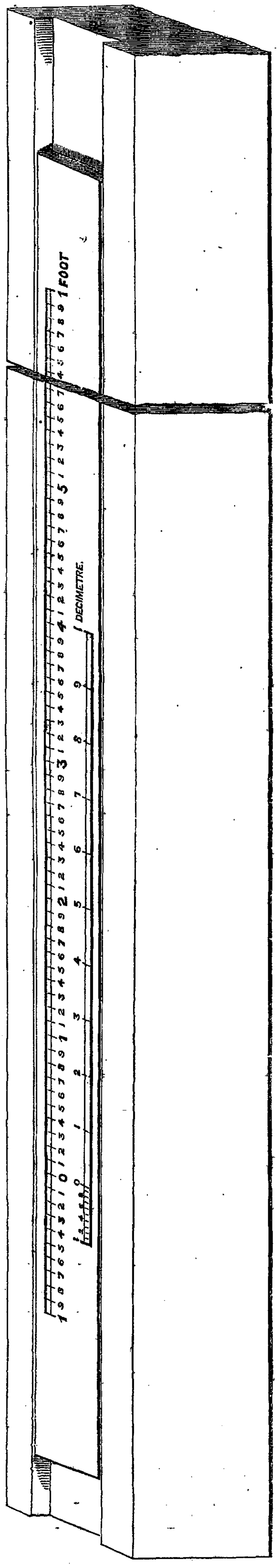
	in.		
Expansion of bronze bar	=0·000341	in 36 in.	for 1° F.
„ brass	=0·000344	„	„
Difference	=0·000003	„	„
Or	0·000001	in 12 inches.	

Actual
parisoı
3 feet c

The following comparisons have been made of the three feet marked on SS., 36 readings having been taken in each comparison:—

PLATE V.

GRADUATED BRASS SLIDER S, AN AUXILIARY STANDARD MEASURE FOR COMPARING SUBDIVISIONS OF STANDARDS OF LENGTH.



Appendix VII.—*continued.*

Comparisons of subdivided Feet of Bronze Yard SS. with Brass Slider S.

No.	Date of Comparison.	Compared Standard.	Comparing Standard.	Difference of compared Standard in Divisions of Micrometer.	Bar next Observer.	Number of each Micrometer used.	Result in Parts of an Inch.	Temperature, Faht.	Correction for Temperature.	Result in Parts of an Inch. $t = 62°$.
	1870.					Nos.		°		
(1)	April 8	SS. 0–12 in. =	S. Foot	−4·1	S.	1, 3	−0·00013760	55	−0·000007	−0·00014460
(2)	„ „	„ 12–24 „ =	„	−6·5	S.	3, 4	−0·00021699	56	−0·000006	−0·00022290
(3)	„ „	„ 24–36 „ =	„	+1·7	S.	4, 2	+0·00008416	57	−0·000005	+0·00008916
(4)	„ 11	„ 0–12 „ =	„	−1·3	SS.	4, 2	−0·00003037	59	−0·000003	−0·00003337
(5)	„ „	„ 12–24 „ =	„	+0·4	SS.	3, 4	+0·00001942	59	−0·000003	+0·00002242
(6)	„ „	„ 24–36 „ =	„	−7·0	SS.	1, 3	−0·00024164	59	−0·000003	−0·00024464
(7)	„ 13	„ 0–12 „ =	„	−2·2	—	4, 2	−0·00006205	60	−0·000002	−0·00006225
(8)	„ „	„ 12–24 „ =	„	−0·7	—	3, 4	−0·00002974	62	−0·000000	−0·00002974
(9)	„ „	„ 24–36 „ =	„	−1·4	—	1, 3	−0·00005411	60	−0·000002	−0·00005611
(10)	„ 14	„ 0–12 „ =	„	−2·4	—	1, 3	−0·00008401	56	−0·000006	−0·00009001
(11)	„ „	„ 12–24 „ =	„	+0·2	—	3, 4	+0·00001103	56·5	−0·000005	+0·00001603
(12)	„ „	„ 24–36 „ =	„	−0·1	—	4, 2	+0·00002288	57	−0·000005	+0·00001788

Reductions of Comparisons.

				Mean ascertained Error.	Mean Standard Length.
	SS. S.			Inch.	Inch.
(1)	0–12 = Foot	−0·00014460			
(4)	„ = „	−0·00003337			
(7)	„ = „	−0·00006225			
(10)	„ = „	−0·00009001			
		−0·00033023	SS. S.		
			Mean 0–12 = Foot - -	−0·00008256	
(2)	12–24 = Foot	−0·00022290			
(5)	„ = „	−0·00002242			
(8)	„ = „	−0·00002974			
(11)	„ = „	−0·00001603			
		−0·00029109			
			Mean 12–24 = Foot - -	−0·00007277	
(3)	24–36 = Foot	−0·00008916			
(6)	„ = „	−0·00024464			
(9)	„ = „	−0·00005611			
(12)	„ = „	+0·00001788			
		−0·00037203			
			Mean 24–36 = Foot - -	−0·00009301	
		SS. SS.			
	Whence	0–12 = 12–24	- - -	−0·00000979	
		0–12 = 24–36	- - -	+0·00001045	
(XIX., p. 13)	Yard SS.	(0–36) = 3 feet	- - -	−0·00009050	
	And	3 (0–12) = „	- - -	−0·00008984	
	∴ at 62° F.	0–12 = 1 foot	- - -	−0·00002995	11·99997005
		12–24 = „	- - -	−0·00002015	11·99997985
		24–36 = „	- - -	−0·00004040	11·99995960
		Yard (0–36) = 3 feet	- - -	−0·00009050	35·99990950
		and Foot S. = 1 foot	- - -	+0·00005261	12·00005261

Appendix VII.—*continued.*

2. *Verification of each Length of* 4 *Inches,* 24–28, 28–32, 32–36, *and* 36–40 *of SS.*

In order to verify the four inches 36–40 of SS., the following verifications have been made of the several lengths of four inches each in the foot 24–36, by comparing each length of four inches with four inches of the slider S., and then ascertaining the exact length of each third part of the foot 24–36 of SS.

Verification of 4 inches, 36–40 of SS., &c.

Mean of Twelve Readings each, by Mr. Chisholm and Mr. Chaney, on 11*th July, with Micrometer No.* 1 *for the compared, and No.* 4 *for the comparing Standard.*

			Div.	Div.	In.
(1)	Mr. Chisholm	24–28 of SS. = 0–4 of S.	+7·06	+6·83	+0·00017040
(2)	„ Chaney		+6·66		
(3)	„ Chisholm	28–32 of SS. = 0–4 of S.	−4·86	−3·63	−0·00013685
(4)	„ Chaney		−2·40		
(5)	„ Chisholm	32–36 of SS. = 0–4 of S.	−6·86	−5·13	−0·00020112
(6)	„ Chaney		−3·40		
(7)	„ Chisholm	36–40 of SS. = 0–4 of S.	−7·90	−8·46	−0·00028872
(8)	„ Chaney		−9·03		

Here from (1) (2) (3) (4) 24–28 of SS. = 28–32 of SS. +0·00030725
(1) (2) (5) (6) „ „ = 32–36 „ +0·00037152
And as 24–36 „ = 1 foot −0·00004040 or 11·99995960

Whence 3 (24–28) „ = 1 foot +0·00063837

∴ 24–28 „ = 4 inches +0·00021279 or 4·00021279
28–32 „ = „ −0·00009446 or 3·99990554
32–36 „ = „ −0·00015873 or 3·99984127
From (1) (2) (7) (8) 24–28 of SS. = 39–40 of SS. +0·00045912
∴ 39–40 = 4 inches −0·00024633 or 3·99975367

3. *Verification of each Inch* 24–25 *to* 39–40 *on SS.*

The standard length of each inch from 24–25 to 39–40, marked on SS., has been in like manner determined, by first comparing these 16 inches successively with the inch 1–0 marked on S, which is the only inch upon the graduated brass slider subdivided into hundredths of inches, and then ascertaining the standard length of every inch in each series of four inches from the preceding determinations, and each of the four inches from 36 to 40 from the inch 24–25.

Verification of inches 24–25 to 39–40 on SS.

Comparison of Inch Subdivisions of SS.

No.	Date of Comparison.		Compared Standard.		Comparing Standard.	Difference of compared Standard in Divisions of Micrometer.	Nos. of Micrometers used.	Results in Parts of an Inch.
	1870.		Inch SS.		Inch S.	Div.		Inch.
(13)	May	23	24–25	=	1–0	+4·3	3, 4	+0·00013400
(14)	„	„	25–26	=	„	+2·7	3, 4	+0·00008427
(15)	„	13	26–27	=	„	−0·3	3, 4	−0·00002195
(16)	„	„	27–28	=	„	−2·0	3, 4	−0·00006103
(17)	„	12	28–29	=	„	+6·3	3, 4	+0·00019952
(18)	„	„	29–30	=	„	+1·0	3, 4	+0·00002667
(19)	„	„	30–31	=	„	+5·0	3, 4	+0·00015847
(20)	„	„	31–32	=	„	−1·2	3, 4	−0·00004389
(21)	„	11	32–33	=	„	+1·7	3, 4	+0·00005145
(22)	„	„	33–34	=	„	−0·2	3, 4	−0·00001091
(23)	„	„	34–35	=	„	−1·6	3, 4	−0·00005629
(24)	„	„	35–36	=	„	−0·6	3, 4	−0·00002260
(25)	„	10	36–37	=	„	−2·4	3,4	−0·00008301
(26)	„	„	37–38	=	„	+2·4	3, 4	+0·00007416
(27)	„	„	38–39	=	„	−1·2	3, 4	−0·00004688
(28)	„	„	39–40	=	„	−0·2	3, 4	−0·00001356

Reduction of Comparisons.

Inch. Inch.
Here from (13) (14) 24–25 of SS. = 25–26 of SS. +0·00004973
(13) (15) „ = 26–27 +0·00015595
(13) (16) „ = 27–28 +0·00020303
And as 24–28 = 4 inches +0·00021279 or 4·00021279

Whence 4 (24–25) = 4 inches +0·00062150

∴ 24–25 = 1 inch +0·00015537 or 1·00015537
25–26 = „ +0·00010564 or 1·00010564
26–27 = „ −0·00000057 or 0·99999943
27–28 = „ −0·00004755 or 0·99995235

Appendix VII.—*continued.*

			Inch.	Inch.
From (17) (18) 28–29 of SS.	=	29–30 of SS.	+0·00017285	
(17) (19) ,,	=	30–31	+0·00004105	
(17) (20) ,,	=	31–32	+0·00024341	
And as 28–32	=	4 inches	—0·00009446	or 3·99990554
Whence 4 (28–29)	=	4 inches	+0·00036285	
∴ 28–29	=	1 inch	+0·00009071	or 1·00009071
29–30	=	,,	—0·00008214	or 0·99991786
30–31	=	,,	+0·00004967	or 1·00004967
31–32	=	,,	—0·00015270	or 0·99984730

From (21) (22) 32–33 of SS.	=	33–34 of SS.	+0·00006236	
(21) (23) ,,	=	34–35	+0·00010774	
(21) (24) ,,	=	35–36	+0·00007405	
And as 32–36	=	4 inches	—0·00015873	or 3·99984127
Whence 4 (32–33)	=	4 inches	+0·00008542	
∴ 32–33	=	1 inch	+0·00002135	or 1·00002135
33–34	=	,,	—0·00004100	or 0·99995900
34–35	=	,,	—0·00008638	or 0·99991362
35–36	=	,,	—0·00005270	or 0·99994730

From (25) (26) 36–37 of SS.	=	37–38 of SS.	—0·00015717	
(25) (27) ,,	=	38–39	—0·00003613	
(25) (28) ,,	=	39–40	—0·00006945	
And as 36–40	=	4 inches	—0·00024633	or 3·99975367
Whence 4 (36–37)	=	4 inches	—0·00050908	
∴ 36–37	=	1 inch	—0·00012727	or 0·99987273
37–38	=	,,	+0·00002990	or 1·00002990
38–39	=	,,	—0·00009114	or 0·99990886
39–40	=	,,	—0·00005782	or 0·99994218

Verification of tenths and hundredths of inch 36–37.

4. *Verification of Tenths and Hundredths of Inch* 36–37 *of SS.*

Comparison of Tenths of Inch 36–37 *on 2nd June* 1870.

		Div.			Div.
Tenth	36·0 – 36·1 =	3139	Tenth	36·5 – 36·6 =	3139
	36·1 – 36·2 =	3141		36·6 – 36·7 =	3140
	36·2 – 36·3 =	3139		36·7 – 36·8 =	3144
	36·3 – 36·4 =	3138		36·8 – 36·9 =	3140
	36·4 – 36·5 =	3140		36·9 – 37·0 =	3142

Compared Tenth.		Comparing Tenth.	Difference of compared		Ascertained Error of compared Tenth.	Standard Length of compared Tenth at 62° F.	
			In Div.	In Inch.			
					Inch.	Inch.	
36·0–36·1	-	- -	—	—	−0·00005110	0·09994890	
36·1–36·2	=	36·0–36·1	+ 2	+0·00006396	+0·00001285	0·10001285	
36·2–36·3	=	,,	—	—	−0·00005110	0·09994890	
36·3–36·4	=	,,	− 1	−0·00003198	−0·00008308	0·09991692	
36·4–36·5	=	,,	+ 1	+0·00003198	−0·00001912	0·09998088	
36·5–36·6	=	,,	—	—	−0·00005110	0·09994890	
36·6–36·7	=	,,	+ 1	+0·00003198	−0·00001912	0·09998088	
36·7–36·8	=	,,	+ 5	+0·00015990	+0·00010879	0·10010879	
36·8–36·9	=	,,	+ 1	+0·00003198	−0·00001912	0·09998088	
36·9–37·0	=	,,	+ 3	+0·00009594	+0·00004483	0·10004483	
Here 10 (36·0–36·1) = Inch 36–37 -				−0·00038376			
Ascertained error of ,, -				−0·00012727	−0·00012727	0·99987273	= Inch 36–37.
,, of 10 (36·0–36·1) -				−0·00051103			
And consequently Half Inch 36–36·5 - - -					−0·00018884	0·49981116	
,, ,, 36·5–37 - - -					+0·00006614	0·50006614	

Appendix VII.—*continued.*

Verification of Hundredths of Inch 36–37, on 2nd June 1870.

In stating the comparison of the hundredths of the inch 36–37, it will be seen that the number of divisions of micrometer No. 1 are shown, which are contained in each hundredth included in each tenth of the inch; the first hundredth of each tenth being taken as the zero of comparison for determining the relative length of the other nine hundredths, and thus the actual length of each hundredth from the ascertained length of each tenth.

Comparison of Hundredths 36·00–36·10 in Tenth 36·0–36·1.

Div.
Hundredth - - - 36·00–36·01 = 313
„ - - 36·01–36·02 = 315
„ - - 36·02–36·03 = 316
„ - - 36·03–36·04 = 314
„ - - 36·04–36·05 = 314

Div.
Hundredth - - 36·05–36·06 = 315
„ - - 36·06–36·07 = 313
„ - - 36·07–36·08 = 319
„ - - 36·08–36·09 = 316
„ - - 36·09–36·10 = 316

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth, at 62 F.	
		In Div.	In Inch.			
				In.	In.	
36·00–36·01 - - -		—	—	−0·00003389	0·00996611	
36·01–36·02 =	36·00–36·01	+1	+0·00003198	−0·00000191	0·00999809	
36·02–36·03 =	„	+4	+0·00012792	+0·00009403	0·01009403	
36·03–36·04 =	„	+1	+0·00003198	−0·00000191	0·00999809	
36·04–36·05 =	„	−2	−0·00006396	−0·00009785	0·00990215	
36·05–36·06 =	„	+4	+0·00012792	+0·00009403	0·01009403	
36·06–36·07 =	„	−4	−0·00012796	−0·00016181	0·00983819	
36·07–36·08 =	„	+2	+0·00006394	+0·00003006	0·01003006	
36·08–36·09 =	„	+3	+0·00009594	+0·00006204	0·01006204	
36·09–36·10 =	„	—	—	−0·00003389	0·00996611	
Here 10 (36·00–36·01) = Tenth 36·0–36·1			−0·00028782			
Ascertained error of „			−0·00005110	−0·00005110	0·09994890	= Tenth 36·0–36·1.
„ of 10 (36·00–36·01) -			−0·00033892			

Comparison of Hundredths 36·10–36·20.

Div.
Hundredth - - 36·10–36·11 = 315
„ - - 36·11–36·12 = 315
„ - - 36·12–36·13 = 315
„ - - 36·13–36·14 = 311
„ - - 36·14–36·15 = 315

Div.
Hundredth - - 36·15–36·16 = 312
„ - - 36·16–36·17 = 314
„ - - 36·17–36·18 = 316
„ - - 36·18–36·19 = 316
„ - - 36·19–36·20 = 312

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth, at 62° F.	
		In Div.	In Inch.			
				In.	In.	
36·10–36·11 - - -		—	—	+0·00003006	0·01003006	
36·11–36·12 =	36·10–36·11	—	—	+0·00003006	0·01003006	
36·12–36·13 =	„	—	—	+0·00003006	0·01003006	
36·13–36·14 =	„	−4	−0·00012792	−0·00009784	0·00990216	
36·14–36·15 =	„	—	—	+0·00003006	0·01003006	
36·15–36·16 =	„	−3	−0·00009594	−0·00006587	0·00993413	
36·16–36·17 =	„	−1	−0·00003198	−0·00000191	0·00999809	
36·17–36·18 =	„	+1	+0·00003198	+0·00006205	0·01006205	
36·18–36·19 =	„	+1	+0·00003198	+0·00006205	0·01006205	
36·19–36·20 =	„	−3	−0·00009594	−0·00006587	0·00993413	
Here 10 (36·10–36·11) = Tenth 36·1–36·2			+0·00028780			
Ascertained error of „			+0·0001285	+0·0001285	0·10001285	= Tenth 36·1–36·2.
„ of 10 (36·10–36·11) -			+0·00030065			

Appendix VII.—*continued.*

Comparison of Hundredths 36·20–36·30.

Div.
Hundredth - - 36·20–36·21 = 316
" - - 36·21–36·22 = 316
" - - 36·22–36·23 = 305
" - - 36·23–36·24 = 317
" - - 36·24–36·25 = 319

Div.
Hundredth - - 36·25–36·26 = 315
" - - 36·26–36·27 = 312
" - - 36·27–36·28 = 313
" - - 36·28–36·29 = 316
" - - 36·29–36·30 = 310

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth, at 62° F.	
		In Div.	In Inch.			
				In.	In.	
36·20–36·21 =	- -	—	—	+0·00006205	0·01006205	
36·21–36·22 =	36·20–36·21	—	—	+0·00006205	0·01006205	
36·22–36·23 =	"	−11	−0·00035178	−0·00028973	0·00971027	
36·23–36·24 =	"	+1	+0·00003198	+0·00009402	0·01009402	
36·24–36·25 =	"	+3	+0·00009594	+0·00015798	0·01015798	
36·25–36·26 =	"	−1	−0·00003198	+0·00003007	0·01003007	
36·26–36·27 =	"	−4	−0·00012792	−0·00006587	0·00993413	
36·27–36·28 =	"	−3	−0·00009594	−0·00003389	0·00996611	
36·28–36·29 =	"	—	—	+0·00006205	0·01006205	
36·29–26·30 = 7.	"	−6	−0·00019188	−0·00012983	0·00987017	
Here 10 (36·20–36·21) = Tenth 36·2–36·3			+0·00067158			
Ascertained error of "			−0·00005110	−0·00005110	0·09994890	= Tenth 36·2–36·3.
" of 10 (36·20–36·21) -			+0·00062048			

Comparison of Hundredths 36·30–36·40.

Div.
Hundredth - - 36·30–36·31 = 314
" - - 36·31–36·32 = 316
" - - 36·32–36·33 = 316
" - - 36·33–36·34 = 313
" - - 36·34–36·35 = 313

Div.
Hundredth - - 36·35–36·36 = 315
" - - 36·36–36·37 = 311
" - - 36·37–36·38 = 313
" - - 36·38–36·39 = 319
" - - 36·39–36·40 = 308

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth at 62° F.	
		In Div.	In Inch.			
				In.	In.	
36·30–36·31 -	- -	—	—	−0·00000831	0·00999169	
36·31–36·32 =	36·30–36·31	+2	+0·00006396	+0·00005565	0·01005565	
36·32–36·33 =	"	+2	+0·00006396	+0·00005565	0·01005565	
36·33–36·34 =	"	−1	−0·00003198	−0·00004029	0·00995971	
36·34–36·35 =	"	−1	−0·00003198	−0·00004029	0·00995971	
36·35–36·36 =	"	+1	+0·00003198	+0·00002368	0·01002368	
36·36–36·37 =	"	−3	−0·00009594	−0·00010425	0·00989575	
36·37–36·38 =	"	+1	+0·00003198	+0·00002368	0·01002368	
36·38–36·39 =	"	+5	+0·00015990	+0·00015159	0·01015159	
36·39–36·40 =	"	−6	−0·00019188	−0·00020059	0·00979981	
Here 10 (36·30–36·31) = Tenth 36·3–36·4			0·00000000			
Ascertained error of "			−0·00008308	−0·00008308	0·09991692	= Tenth 36·3–36·4.
" of 10 (35·30–36·31) -			−0·00008308			

Appendix VII.—*continued.*

Comparison of Hundredths 36·40–36·50.

Div.
Hundredth - - 36·40–36·41 = 314
„ - - 36·41–36·42 = 318
„ - - 36·42–36·43 = 314
„ - - 36·43–36·44 = 315
„ - - 36·44–36·45 = 312

Div.
Hundredth - - 36·45–36·46 = 316
„ - - 36·46–36·47 = 314
„ - - 36·47–36·48 = 311
„ - - 36·48–36·49 = 318
„ - - 36·49–36·50 = 308

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth, at 62° F.	
		In Div.	In Inch.			
				In.	In.	
36·40–36·41	- - -	—	—	+ 0·00001088	0·01001088	
36·41–36·42	= 36·40–36·41	+4	+ 0·00002792	+ 0·00013880	0·01013880	
36·42–36·43	= „	—	—	+ 0·00001088	0·01001088	
36·43–36·44	= „	+1	+ 0·00003198	+ 0·00004286	0·01004286	
36·44–36·45	= „	−2	− 0·00006396	− 0·00005308	0·00994692	
36·45–36·46	= „	−2	− 0·00006396	− 0·00005308	0·00994692	
36·46–36·47	= „	—	—	+ 0·00001088	0·01001088	
36·47–36·48	= „	−3	− 0·00009594	− 0·00008506	0·00991494	
36·48–36·49	= „	+4	+ 0·00012792	+ 0·00013880	0·01013880	
36·49–36·50	= „	−6	− 0·00019188	− 0·00018100	0·00981900	
Here 10 (36·40–36·41) = Tenth + 36·4–36·5			+ 0·00012792			
Ascertained error of „ „			− 0·00001912	− 0·00001912	0·09998088	= Tenth 36·4 – 36·5.
„ of 10 (36·40–36·41) -			+ 0·00010880			

Comparison of Hundredths 36·50–36·60.

Div.
Hundredth - - 36·50–36·51 = 315
„ - - 36·51–36·52 = 317
„ - - 36·52–36·53 = 315
„ - - 36·53–36·54 = 312
„ - - 36·54–36·55 = 308

Div.
Hundredth - - 36·55–36·56 = 320
„ - - 35·56–36·57 = 312
„ - - 36·57–36·58 = 315
„ - - 36·58–36·59 = 314
„ - - 36·59–36·60 = 311

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth, at 62° F.	
		In Div.	In Inch.			
				In.	In.	
36·50–46·51	- - -	—	—	+ 0·00003007	0·01003007	
36·51–36·52	= 36·50–36–51	+2	+ 0·00006396	+ 0·00009402	0·01009402	
36·52–56·53	= „	—	—	+ 0·00003007	0·01003007	
36·53–36·54	= „	−3	− 0·00009594	− 0·00006587	0·00993413	
36·54–36·55	= „	−7	− 0·00022386	− 0·00019379	0·00980621	
36·55–36·56	= „	+5	+ 0·00015990	+ 0·00018996	0·01018996	
36·56–36·57	= „	−3	− 0·00009594	− 0·00006587	0·00993413	
36·57–36·58	= „	—	—	+ 0·00003007	0·01003007	
36·58–36·59	= „	−1	− 0·00003198	− 0·00000191	0·00999809	
36·59–36·60	= „	−4	− 0·00012792	− 0·00009785	0·00990215	
Here 10 (36·50–36·51) = Tenth 36·5–36·6			+ 0·00035178			
Ascertained error of „ „			− 0·00005110	−0·00005110	0·09994890	= Tenth 36·5 – 36·6.
„ of 10 (36·50–36·51) -			+ 0·00030068			

Appendix VII.—*continued.*

Comparison of Hundredths 36·60–36·70.

		Div.
Hundredth -	- 36·60–36·61 =	313
„ -	- 36·61–36·62 =	318
„ -	- 36·62–37·63 =	311
„ -	- 36·63–36·64 =	315
„ -	- 36·64–36·65 =	311
Hundredth -	- 36·65–36·66 =	317
„ -	- 36·66–36·67 =	314
„ -	- 36·67–36·68 =	311
„ -	- 36·68–36·69 =	316
„ -	- 36·69–36·70 =	314

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth, at 62° F.	
		In Div.	In Inch.			
				In.	In.	
36·60–36·61 - - -		—	—	– 0·00003389	0·00996611	
36·61–36·62 =	36·60–36·61	+5	+ 0·00015990	+ 0·00012601	0·01012601	
36·62–36·63 =	„	–2	– 0·00006396	– 0·00009785	0·00990215	
36·63–36·64 =	„	+2	+ 0·00006396	+ 0·00003007	0·01003007	
36·64–36·65 =	„	–2	– 0·00006396	– 0·00009785	0·00990215	
36·65–36·66 =	„	+4	+ 0·00012792	+ 0·00009403	0·01009403	
36·66–36·67 =	„	+1	+ 0·00003198	– 0·00000192	0·00999808	
36·67–36·68 =	„	–2	– 0·00006396	– 0·00009785	0·00990215	
36·68–36·69 =	„	+3	+ 0·00009594	+ 0·00006205	0·01006205	
36·69–36·70 =	„	+1	+ 0·00003198	– 0·00000192	0·00999808	
Here 10 (36·60–36·61) = Tenth 36·6–36·7			– 0·00031980			
Ascertained error of „ „			– 0·00001912	– 0·00001912	0·09998088	=Tenth 36·6–36·7.
„ of 10 (36·60 – 36·61) -			– 0·00033892			

Comparison of Hundredths 36·70–36·80.

		Div.
Hundredth -	- 36·70–36·71 =	319
„ -	- 36·71–36·72 =	314
„ -	- 36·72–36·73 =	314
„ -	- 36·73–36·74 =	311
„ -	- 36·74–36·75 =	310
Hundredth -	- 36·75–36·76 =	317
„ -	- 36·76–30·77 =	313
„ -	- 36·77–36·78 =	312
„ -	- 36·78–36·79 =	318
„ -	- 36·79–36·80 =	316

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth, at 62° F.	
		In Div.	In Inch.			
				In.	In.	
36·70–36·71 - - -		—	—	+ 0·00015799	0·01015799	
36·71–36·72 =	36·70–36·71	–5	– 0·00015990	– 0·00000192	0·00999808	
36·72–36·73 =	„	–5	– 0·00015990	– 0·00000192	0·00999808	
36·73–36·74 =	„	–8	– 0·00025584	– 0·00009786	0·00990214	
36·74–36·75 =	„	–9	– 0·00028782	– 0·00012984	0·00987016	
36·75–36·76 =	„	–2	– 0·00006396	– 0·00009405	0·01009405	
36·76–36·77 =	„	–6	– 0·00019188	+ 0·00003389	0·00996611	
36·77–36·78 =	„	–7	– 0·00022386	– 0·00006588	0·00993412	
36·78–36·79 =	„	–1	– 0·00003198	+ 0·00012601	0·01012601	
36·79–36·80 =	„	–3	– 0·00009594	+ 0·00006205	0·01006205	
Here 10 (36·70–36·71)=Tenth 36·7–36·8			+ 0·00147108			
Ascertained error of „ „			+ 0·00010879	+ 0·00010879	0·10010879	=Tenth 36·7–36·8.
„ of 10 (36·70 – 36·71) -			+ 0·00157988			

Appendix VII.—*continued.*

Comparison of Hundredths 36·80–36·90.

		Div.			Div.
Hundredth - -	36·80–36·81 =	316	Hundredth - -	36·85–36·86 =	317
„ - -	36·81–36·82 =	315	„ - -	36·86–36·87 =	315
„ - -	36·82–36·83 =	316	„ - -	36·87–36·88 =	313
„ - -	36·83–36·84 =	312	„ - -	36·88–36·89 =	317
„ - -	36·84–36·85 =	310	„ - -	36·89–36·90 =	309

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth, at 62° F.	
		In Div.	In Inch.			
				In.	In.	
36·80–36·81 - - -		—	—	+ 0·00006205	0·01006205	
36·81–36·82 =	36·80–36·81	– 1	– 0·00003198	+ 0·00003007	0·01003007	
36·82–36·83 =	„	—	—	+ 0·00006205	0·01006205	
36·83–36·84 =	„	– 4	– 0·00012792	– 0·00006588	0·00993412	
36·84–36·85 =	„	– 6	– 0·00019188	– 0·00012984	0·00987016	
36·85–36·86 =	„	+ 1	+ 0·00003198	+ 0·00009403	0·01009403	
36·86–36·87 =	„	– 1	– 0·00003198	+ 0·00003007	0·01003007	
36·87–36·88 =	„	– 3	– 0·00009594	– 0·00003389	0·00996611	
36·88–36·89 =	„	+ 1	+ 0·00003198	+ 0·00009403	0·01009403	
33·89–36·90 =	„	– 7	– 0·00022386	– 0·00016181	0·00983819	
Here 10 (36·80–36·81) = Tenth 36·8–36·9			+ 0·00063960			
Ascertained error of „ „			– 0·00001912	– 0·00001912	0·09998088	= Tenth 36·8 – 36·9.
„ „ of 10 (36·80–36·81)			+ 0·00062048			

Comparison of Hundredths 36·90–37·0.

		Div.			Div.
Hundredth - -	36·90–36·91 =	316	Hundredth - -	36·95–36·96 =	317
„ - -	36·91–36·92 =	314	„ - -	36·96–36·97 =	310
„ - -	36·92–36·93 =	317	„ - -	36·97–36·98 =	315
„ - -	36·93–36·94 =	311	„ - -	36·98–36·99 =	316
„ - -	36·94–37·95 =	313	„ - -	36·99–37·00 =	313

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth, at 62° F.	
		In Div.	In Inch.			
				In.	In.	
36·90–36·91 - - -		—	—	+ 0·00006205	0·01006205	
36·91–36·92 =	36·90–36·91	– 2	– 0·00006396	– 0·00000192	0·00999808	
36·92–36·93 =	„	+ 1	+ 0·00003198	+ 0·00009403	0·01009403	
36·93–36·94 =	„	– 5	– 0·00015990	– 0·00009785	0·00990215	
36·94–36·95 =	„	– 3	– 0·00009594	– 0·00003390	0·00996610	
36·95–36·96 =	„	+ 1	+ 0·00003198	+ 0·00009403	0·01009403	
36·96–36·97 =	„	– 6	– 0·00019188	– 0·00012983	0·00987017	
36·97–36·98 =	„	– 1	– 0·00003198	+ 0·00003007	0·01003007	
36·98–36·99 =	„	—	—	+ 0·00006205	0·01006205	
36·99–37·00 =	„	– 3	– 0·00009594	– 0·00003390	0·00996610	
Here 10 (36·90–36·91) = Tenth 36·9–37·0			+ 0·00057564			
Ascertained error of „ „			+ 0·00004483	+ 0·00004483	1·00004483	= Tenth 36·9 – 37·0.
„ „ of 10 (36·90–36·91)			+ 0·00062047			

Appendix VII.—*continued.*

Final Verification of one Division of each Micrometer of the New Comparing Apparatus.

Final determination of the value of one division of each micrometer.

As soon as the actual standard length of each of the smaller subdivisions of the imperial yard, marked on the new subdivided standard SS. had been ascertained, so far as this could be done, by taking the provisional value of one division of each micrometer used in the respective comparisons, the requisite means were afforded of finally determining the value of one division of each micrometer from the standard length of the inch marked SS., subdivided into hundredths of an inch. To complete the process so as to arrive at the greatest possible accuracy, involves the making all the necessary corrections in the results of the several comparisons previously made by means of these micrometers, both as regards the standard length of the yard, and its subdivisions marked on SS., and again in finally determining the value of a division of each micrometer from the corrected values of the subdivisions of SS.

Preliminary observations.

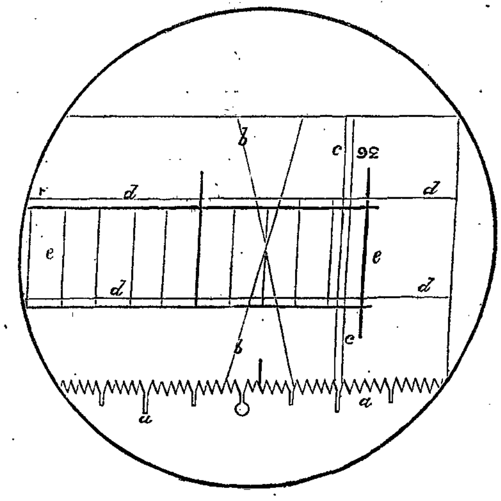
Before making the actual comparisons for this purpose, some observations were made with a view of determining whether the same value should be attached to one division throughout the whole length of the screw of the microscope, or to what extent the range might be safely extended, right and left, as seen from the middle of the field of each microscope.

View of field of microscope and measuring rack.

The following figures exhibit a view of the field of each microscope of about the size seen on looking through the eye piece, and show the metal rack fixed in the screw chamber, which serves to measure the number of turns of the screw by means of a traversing pointer. The distance from one tooth to another denotes one turn of the screw, or 100 divisions of the micrometer, the circumference of the micrometer head being divided into 100 equal parts.

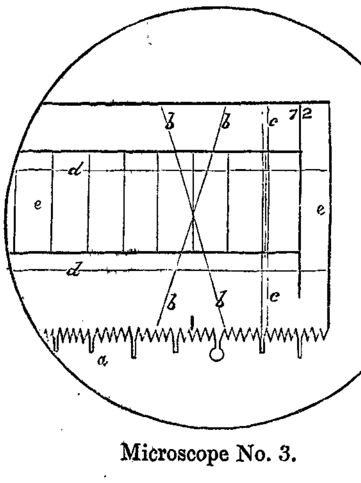
View of the fields of microscopes Nos. 1, 2, 3, and 4, showing the cobweb lines of each microscope, viz., cross lines *bb*, parallel lines *cc*, longitudinal lines *dd*, and the metal measuring rack *a*; together with the first hundredths of inch 36–37, *ee*, marked on SS.

Fig. 1.



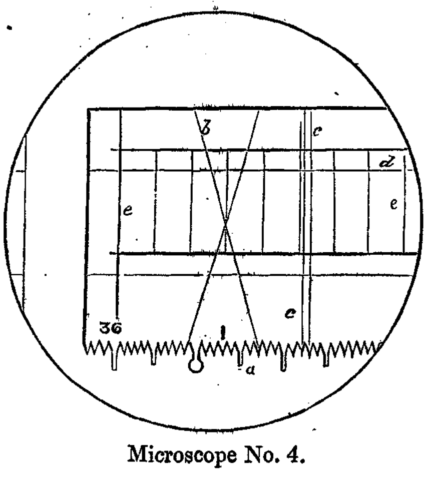
Microscopes Nos. 1 and 2.

Fig. 2.



Microscope No. 3.

Fig. 3.

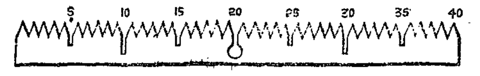


Microscope No. 4.

During comparisons, the number of teeth passed over can be easily counted from observing the defining marks of each series of five teeth. No numbers are marked upon the racks, but for more conveniently noting the following observations, numbers have been assigned to the teeth, as shown in the subjoined Fig. 4, beginning on the left, as appears to the eye through the microscope, and the middle of the rack corresponding with the centre of the field, being in each case between teeth No. 20 and 21.

Sketch of Rack of Micrometers, showing the Teeth as numbered in the Comparisons.

Fig. 4.



Value of a division at different parts of the micrometer screw, and field of microscope.

The following comparisons were made by Mr. Chaney on 30th June 1870, for thus determining the value of one division of each micrometer at different parts of the screw and field of the microscope. The hundredth of an inch, 36·00–36·01 or SS=0·00996611 inch, has been used for the comparisons :—

Appendix VII.—*continued.*

Comparisons by Mr. Chaney, for determining the Value of a Division of each Micrometer, at different parts of the Micrometer Screw and Field of each Microscope.

Observations for determining this value.

Micrometer.	Part of Micrometer Screw compared, as shown by the Pointer of the Measuring Rack.		Readings of Micrometer.	Number of Micrometer Divisions contained in hundredth of inch 36·00–36·01 of SS.	Mean of the whole Scale.	Mean of 10–29.	Mean of 17–23.
				Div.			
Micrometer No. 1	Extreme left. No.	1–4	30–342	312			
		4–7	59–373	314			
		7–10	80–394	314			
		10–14	77–389	312			
		14–17	35–346	311			
		17–20	39–351	312			
	Middle of field.						
		20–23	35–348	313			
		23–26	28–339	311			
		26–29	31–343	312			
		29–32	37–347	310			
		32–35	41–352	311			
		35–38	41–351·5	310·5			
	Extreme right.	38–40	0–300·9	300·9	311·03	311·83	312·50
Micrometer No. 2	Extreme left. No.	1–4	66·5–379	312·5			
		4–7	73–385	312			
		7–10	76–387	311			
		10–14	81–395	314			
		14–17	4–314	310			
		17–20	68–379	311			
	Middle of field.						
		20–23	72–383·5	311·5			
		23–26	81–393·5	312·5			
		26–29	59–372	313			
		29–32	72–385	313			
		32–35	56–369	313			
		35–38	64–378	314			
	Extreme right.	38–40	48–364	316	311·04	312·00	311·25
Micrometer No. 3	Extreme left. No.	1–4	35–348	313			
		4–7	43–355	312			
		5–8	62–372	310			
		8–11	74–383	309			
		11–14	78–389	311			
		14–17	82–391·5	309·5			
		17–20	85–396	311			
	Middle of field.						
		20–23	0–309	309			
		23–26	31–341	310			
	Extreme right.	26–29	29–339	310	310·45	310·83	310·0
Micrometer No. 4	Extreme left. No.	7–10	77–385	308			
		10–13	78–386	308			
		13–17	78–385	307			
		17–20	85–392	307			
	Middle of field.						
		20–23	87–396	309			
		23–26	83–393	310			
		26–29	95–404	309			
		29–32	13–318	305			
		32–35	30–338	308			
	Extreme right.	35–38	60–366	306	307·7	307·14	308·0

Each of these readings is the mean of about three separate adjustments of the cobwebs and readings of the micrometer head, but each separate reading was not noted by Mr. Chaney. In order to check these observations and results, a second series of observations was made by Mr. Chisholm on 2nd July, noting each separate adjustment and reading. They are as follows, and they serve to show the several differences in the readings:—

Appendix VII.—*continued.*

Observations by Mr. Chisholm for determining the value of a Division of the Micrometer at different parts of the Screw, and of the field of Microscope No. 2.

—	Teeth of Measuring Rack.	Readings of Micrometer.	Mean Number of Divisions in Hundredths of Inch 36·00–36·01 of SS.
Micrometer No. 2	5–8	52·5 ... 368·4	
		55·0 ... 364·0	
		53·3 ... 365·5	
		55·0 ... 367·7	
		55·5 ... 367·0	
		51·5 ... 368·0	
		53·8 ... 366·76	=312·96
	8–11	69·8 ... 380·6	
		69·0 ... 380·4	
		70·5 ... 380·8	
		69·5 ... 379·8	
		69·0 ... 380·1	
		69·4 ... 379·0	
		69·53 ... 380·13	=310·60
	11–14	80·8 ... 390·0	
		79·9 ... 391·8	
		82·0 ... 392·0	
		81·8 ... 392·0	
		80·0 ... 390·0	
		82·0 ... 389·5	
		81·08 ... 391·88	=310·80
	14–17	98·3 ... 408·8	
		98·0 ... 408·2	
		98·3 ... 409·0	
		97·9 ... 409·0	
		97·8 ... 408·3	
		98·0 ... 407·5	
		98·05 ... 48·46	=310·41
	17–20	12·4 ... 323·0	
		11·0 ... 324·0	
		11·4 ... 324·5	
		11·6 ... 323·0	
		11·3 ... 323·2	
		11·8 ... 323·1	
		11·58 ... 323·46	=311·88
	20–23	6·9 ... 317·1	
		5·0 ... 316·5	
		5·5 ... 317·2	
		7·0 ... 316·6	
		5·0 ... 316·8	
		4·2 ... 315·4	
		5·6 ... 316·6	=311·00

Observations by Mr. Chisholm—cont.

—	Teeth of Measuring Rack.	Readings of Micrometer.	Mean Number of Divisions in Hundredths of Inch 36·00–36·01 of SS.
Micrometer No. 2	23–26	17·8 ... 330·8	
		18·3 ... 331·4	
		17·4 ... 330·9	
		17·3 ... 331·4	
		18·1 ... 331·2	
		17·2 ... 330·0	
		17·68 ... 330·95	=313·27
	26–29	27·8 ... 342·9	
		29·8 ... 341·8	
		29·9 ... 342·8	
		30·4 ... 342·8	
		28·6 ... 341·8	
		29·9 ... 341·6	
		29·4 ... 342·28	=312·88
	29·32	42·8 ... 357·5	
		40·4 ... 355·7	
		40·3 ... 354·4	
		40·4 ... 354·0	
		39·9 ... 354·8	
		39·6 ... 356·0	
		40·56 ... 355·40	=314·84
	32–35	59·0 ... 377·0	
		58·3 ... 375·0	
		59·6 ... 378·0	
		60·8 ... 374·0	
		61·8 ... 375·0	
		59·8 ... 375·0	
		59·88 ... 375·66	=315·78

Comparative Readings with Micrometer No. 2.

—	Mr. Chaney.	Mr. Chisholm.	Mean of both.
5–8	312·0	312·96	312·48
8–11	311·0	310·60	310·80
11–14	314·0	310·80	312·40
14–17	310·0	310·41	310·20
17–20	311·0	311·88	311·44
20–23	311·5	311·00	311·25
23–26	312·5	313·27	312·88
26–29	313·0	312·88	312·94
29–32	313·0	314·84	313·92
32–35	313·0	315·78	314·39
Mean of the whole -	312·10	312·44	312·27
„ of 8–29 -	311·33	311·70	311·52
„ of 17–23 - -	311·25	311·44	311·35

Appendix VII.—*continued.*

Results of these comparisons.

It will be seen from these observations that not only the several readings, but the results of the comparisons are more uniform, when the readings are limited to the middle part of the screw and of the field. As also this part is almost always exclusively used in the comparisons of standards, it has been judged proper to rest the determination of the value of a division of each micrometer on observations thus taken, that is to say, with the portion of the screw and field of the microscope between 15 and 25 of the measuring rack.

Comparisons for finally determining the value of one division of each micrometer.

The following comparisons were accordingly made by Mr. Chisholm and Mr. Chaney separately, on 2nd July, for determining the value of a division of each micrometer. The part of the field shown by the middle nine teeth of the measuring rack was taken, and the whole number of divisions ascertained in three hundredths of an inch, 36·00–36·03 of SS. =0·03005823 inch.

—		Mr. Chisholm.			Mr. Chaney.			Mean Number of Divisions in 3-Hundredths of Inch, 36·00–36·03 of SS.	Value of one Division of Micrometer.
		Readings.		Mean Number of Divisions.	Readings.		Mean Number of Divisions.		
Micrometer, No. 1.	36·03–36·00	52·5 ...	992·0		50·0 ...	988·5			
		52·0 ...	992·2		49·5 ...	989·0			
		53·0 ...	993·0		48·0 ...	990·0			
	Mean	52·5 ...	992·4	=939·9	49·16 ...	989·16	=940·0	939·95	0·00003198
„ No. 2.		49·0 ...	994·5		50·0 ...	995·0			
		49·4 ...	993·5		50·5 ...	995·0			
		49·8 ...	993·5		51·0 ...	995·0			
	Mean	49·4 ...	993·83	=944·43	50·5 ...	995·0	=944·5	944·46	0·00003183
„ No. 3.		32·5 ...	966·5		31·5 ...	965·0			
		32·5 ...	965·2		32·0 ...	965·5			
		33·2 ...	965·0		32·0 ...	965·0			
	Mean	32·73 ...	965·56	=932·83	31·83 ...	965·16	=933·33	933·08	0·00003221
„ No. 4.		57·5 ...	988·0		57·0 ...	985·5			
		57·0 ...	987·0		55·0 ...	985·5			
		57·3 ...	987·0		56·0 ...	986·0			
	Mean	57·26 ...	987·33	=930·06	56·0 ...	985·66	=929·6	929·83	0·00003233

Results of these comparisons.

The difference between the values of one division of each micrometer thus determined, with those provisionally determined in January 1868, and stated in App. VII. p. 99, is as follows :—

—		Provisional Determination in 1868.		Final Determination in 1870.
			In.	In.
Micrometer, No. 1	-	From mean of two separate comparisons of each tenth of the divided inch, D.	0·00003187	0·00003198
„ No. 2	-	From ditto - - - - - -	0·00003188	0·00003183
„ No. 3	-	From mean of two separate comparisons of each 0·05 inch of the subdivided inch 36–37 of SS.	0·00003211	0·00003221
„ No. 4	-	From ditto - - - - - -	0·00003225	0·00003233

The corrected value of the divided inch D, and of the subdivided inch 36–37 of SS., does not affect even the last decimal figure of the comparisons in 1868. The differences between the determinations of 1868 and 1870 are attributable partly to the greater field of the microscopes in the comparisons of 1868, partly perhaps to the wear of two years in the screws, and partly to differences of observations at the two periods.

The values of one division of each micrometer as now determined may be considered satisfactory, as ascertained from the number of divisions in the three hundredths of an inch, 36·00–36·03 of SS.

Appendix VII.—*continued.*

Decimal table of value of division of each micrometer. In Imperial measure.

Decimal Table of Values *in Imperial Measure* of the Divisions of each Micrometer according to their final determinations in 870.

No. of Divisions.	Value in Parts of an Inch.			
	No. 1 Micrometer.	No. 2 Micrometer.	No. 3 Micrometer.	No. 4 Micrometer.
1	0·00003198	0·00003183	0·00003221	0·00003233
2	0·00006396	0·00006366	0·00006442	0·00006466
3	0·00009594	0·00009549	0·00009663	0·00009699
4	0·00012792	0·00012732	0·00012884	0·00012932
5	0·00015990	0·00015915	0·00016105	0·00016165
6	0·00019188	0·00019098	0·00019326	0·00019398
7	0·00022386	0·00022281	0·00022547	0·00022631
8	0·00025584	0·00025464	0·00025768	0·00025864
9	0·00028782	0·00028647	0·00028989	0·00029097
10	0·00031980	0·00031830	0·00032210	0·00032330

In Metric measure.

Decimal Table of Values *in Metric Measure* of the Divisions of each Micrometer, computed from the above according to the Table of Metric and Imperial equivalents.

No. of Divisions.	Value in Parts of a Millimetre.			
	No. 1 Micrometer.	No. 2 Micrometer.	No. 3 Micrometer.	No. 4 Micrometer.
1	0·000812277	0·000808467	0·000818119	0·000821167
2	0·001624554	0·001616934	0·001636238	0·001642334
3	0·002436831	0·002425401	0·002454357	0·002463501
4	0·003241098	0·003233868	0·003272476	0·003284668
5	0·004061385	0·004042335	0·004090595	0·004105835
6	0·004873662	0·004850802	0·004908714	0·004927002
7	0·005685939	0·005659269	0·005726833	0·005748169
8	0·006498216	0·006467736	0·006544952	0·006569336
9	0·007310493	0·007276203	0·007363071	0·007390543
10	0·008122770	0·008084670	0·008181190	0·008211670

Verification of twelfths of inch 37–38.

5. *Verification of Twelfths of Inch* 37–38.

This inch is divided into twelfths, numbered respectively 1 to 11. Each twelfth was measured in divisions of micrometer No. 2, both by Mr. Chaney and by Mr. Newport, on 1st June 1870, and the mean of the observations has been taken.

Comparison of Twelfths of Inch 37–38.

	Mr. Chaney.	Mr. Newport.	Mean.
	Div.	Div.	Div.
Twelfth 37 − $37\frac{1}{12}$ =	2619	2614	2616·5
„ $37\frac{1}{12} - 37\frac{2}{12}$ =	2610	2609	2609·5
„ $37\frac{2}{12} - 37\frac{3}{12}$ =	2611	2609	2610·0
„ $37\frac{3}{12} - 37\frac{4}{12}$ =	2612	2606	2609·0
„ $37\frac{4}{12} - 37\frac{5}{12}$ =	2612	2612	2612·0
„ $37\frac{5}{12} - 37\frac{6}{12}$ =	2614	2612	2613·0
„ $37\frac{6}{12} - 37\frac{7}{12}$ =	2614	2611	2612·5
„ $37\frac{7}{12} - 37\frac{8}{12}$ =	2617	2611	2614·0
„ $37\frac{8}{12} - 37\frac{9}{12}$ =	2614	2614	2614·0
„ $37\frac{9}{12} - 37\frac{10}{12}$ =	2625	2626	2625·5
„ $37\frac{10}{12} - 37\frac{11}{12}$ =	2613	2609	2611·0
„ $37\frac{11}{12} - 38$ =	2613	2609	2611·0
	31374	31342	31358

Appendix VII.—*continued.*

Results of Comparisons.

Compared Twelfth.		Comparing Twelfth.	Difference of compared Twelfth		Ascertained Error of compared Twelfth.	Standard Length of compared Twelfth at 62° F.
			In Div.	In Inch.		
Twelfth 37 − $37\frac{1}{12}$	-	- - -	- - -	- - - -	+0·00010341	0·08343674
„ $37\frac{1}{12}$ − $37\frac{2}{12}$	=	37 − $37\frac{1}{12}$	−7·0	−0·00022281	−0·00011940	0·08321393
„ $37\frac{2}{12}$ − $37\frac{3}{12}$	=	„	−6·5	−0·00020689	−0·00010348	0·08322985
„ $37\frac{3}{12}$ − $37\frac{4}{12}$	=	„	−7·5	−0·00023977	−0·00013636	0·08319697
„ $37\frac{4}{12}$ − $37\frac{5}{12}$	=	„	−4·5	−0·00014323	−0·00003982	0·08329351
„ $37\frac{5}{12}$ − $37\frac{6}{12}$	=	„	−3·5	−0·00011184	−0·00000843	0·08332490
„ $37\frac{6}{12}$ − $37\frac{7}{12}$	=	„	−4·0	−0·00012732	−0·00002391	0·08330942
„ $37\frac{7}{12}$ − $37\frac{8}{12}$	=	„	−2·0	−0·00006366	+0·00003975	0·08337308
„ $37\frac{8}{12}$ − $37\frac{9}{12}$	=	„	−2·0	−0·00006366	+0·00003975	0·08337308
„ $37\frac{9}{12}$ − $37\frac{10}{12}$	=	„	+9·0	+0·00028647	+0·00038988	0·08372321
„ $37\frac{10}{12}$ − $37\frac{11}{12}$	=	„	−5·0	−0·00015915	−0·00005574	0·08327759
„ $37\frac{11}{12}$ − 38	=	„	−5·0	−0·00015915	−0·00005575	0·08327758
Here 12 (37 − $37\frac{1}{12}$) = Inch 37 − 38 -				+0·00121101		
Ascertained error of „ -				+0·00002990	+0·00002990	1·00002990
Whence ascertained error of 12 (37 − $37\frac{1}{12}$)				+0·00124091		
Consequently, quarter inch 37 − $37\frac{3}{12}$ - -					−0·00021987	0·24988053
„ „ $37\frac{3}{12}$ − $37\frac{6}{12}$ - -					−0·00018161	0·24981539
„ „ $37\frac{6}{12}$ − $37\frac{9}{12}$ - -					+0·00005559	0·25005559
„ „ $37\frac{9}{12}$ − 38 - -					+0·00027839	0·25027839
And half-inch 37 − $37\frac{6}{12}$ - -					−0·00030408	0·49969592
„ $37\frac{6}{12}$ − 38 - -					+0·00033398	0·50033398

Verification of eighths and sixteenths of inch 38–39.

6. *Verification of Eighths and Sixteenths of Inch 38–39.*

The inch 38–39 is divided into eighths and sixteenths. Each eighth is numbered with small figures 1 to 7 from the inch numbered 38. The following comparisons were made by Mr. Chaney, on 1st June 1870, with micrometer No. 2.

Comparisons of Eighths and Sixteenths of Inch 38–39.

Sixteenth 38 − $38\frac{1}{16}$ = 1962 div.
„ $38\frac{1}{16}$ − $38\frac{2}{16}$ = 1960
„ $38\frac{2}{16}$ − $38\frac{3}{16}$ = 1957
„ $38\frac{3}{16}$ − $38\frac{4}{16}$ = 1963
„ $38\frac{4}{16}$ − $38\frac{5}{16}$ = 1958
„ $38\frac{5}{16}$ − $38\frac{6}{16}$ = 1955
„ $38\frac{6}{16}$ − $38\frac{7}{16}$ = 1961
„ $38\frac{7}{16}$ − $38\frac{8}{16}$ = 1957

Sixteenth $38\frac{8}{16}$ − $38\frac{9}{16}$ = 1961 div.
„ $38\frac{9}{16}$ − $38\frac{10}{16}$ = 1958
„ $38\frac{10}{16}$ − $38\frac{11}{16}$ = 1958
„ $38\frac{11}{16}$ − $38\frac{12}{16}$ = 1961
„ $38\frac{12}{16}$ − $38\frac{13}{16}$ = 1960
„ $38\frac{13}{16}$ − $38\frac{14}{16}$ = 1957
„ $38\frac{14}{16}$ − $38\frac{15}{16}$ = 1963
„ $38\frac{15}{16}$ − 39 = 1962

Results of Comparisons.

Compared Sixteenth.		Comparing Sixteenth.	Difference of compared Sixteenth		Ascertained Error of compared Sixteenth.	Standard Length of compared Sixteenth at 62° F.
			In Div.	In Inch.		
Sixteenth 38 − $38\frac{1}{16}$	=	- - -	- - -	- - -	+0·00007190	0·06257190
„ $38\frac{1}{16}$ − $38\frac{2}{16}$	=	38 − $38\frac{1}{16}$	−2	−0·00006366	+0·00000824	0·06250824
„ $38\frac{2}{16}$ − $36\frac{3}{16}$	=	„	−5	−0·00015915	−0·00008725	0·06241275
„ $38\frac{3}{16}$ − $38\frac{4}{16}$	=	„	+1	+0·00003183	+0·00010413	0·06260413
„ $38\frac{4}{16}$ − $38\frac{5}{16}$	=	„	−4	−0·00012732	−0·00005542	0·06244458
„ $38\frac{5}{16}$ − $28\frac{6}{16}$	=	„	−7	−0·00022281	−0·00015091	0·06234909
„ $38\frac{6}{16}$ − $38\frac{7}{16}$	=	„	−1	−0·00003183	+0·00004008	0·06254008
„ $38\frac{7}{16}$ − $38\frac{8}{16}$	=	„	−5	−0·00015915	−0·00008725	0·06241275
„ $38\frac{8}{16}$ − $38\frac{9}{16}$	=	„	−1	−0·00003183	+0·00004008	0·06254008
„ $38\frac{9}{16}$ − $38\frac{10}{16}$	=	„	−4	−0·00012732	−0·00005542	0·06244458
„ $38\frac{10}{16}$ − $31\frac{11}{16}$	=	„	−4	−0·00012732	−0·00005542	0·06244458
„ $38\frac{11}{16}$ − $38\frac{12}{16}$	=	„	−1	−0·00003183	+0·00004008	0·06254008
„ $38\frac{12}{16}$ − $38\frac{13}{16}$	=	„	−2	−0·00006366	+0·00000724	0·06250724
„ $38\frac{13}{16}$ − $38\frac{14}{16}$	=	„	−5	−0·00015915	−0·00008725	0·06241275
„ $38\frac{14}{16}$ − $38\frac{15}{16}$	=	„	+1	+0·00003183	+0·00010413	0·06260413
„ $38\frac{15}{16}$ − 39	=	„	—	—	+0·00007219	0·06257190
Here 16 (38−$38\frac{1}{16}$) = Inch 38–39 -				+0·00124137		
Ascertained error of „				−0·00009114	−0·00009114	0·99990886
And „ 12 (38−$38\frac{1}{16}$)				+0·00115923		

Appendix VII.—*continued.*

	Ascertained Error.	Standard Length at 62° F.
And consequently eighth 38 – $38\frac{1}{8}$	+0·00008014	0·12508014
„ $38\frac{1}{8}$ – $38\frac{2}{8}$	+0·00001688	0·12501688
„ $38\frac{2}{8}$ – $38\frac{3}{8}$	–0·00020633	0·12479367
„ $38\frac{3}{8}$ – $38\frac{4}{8}$	–0·00004717	0·12495283
„ $38\frac{4}{8}$ – $38\frac{5}{8}$	–0·00001534	0·12498466
„ $38\frac{5}{8}$ – $38\frac{6}{8}$	–0·00001534	0·12498466
„ $38\frac{6}{8}$ – $38\frac{7}{8}$	–0·00008001	0·12491999
„ $38\frac{7}{8}$ – 39	+0·00017603	0·12517603

	Ascertained Error.	Standard Length at 62° F.
And quarter inch 38 – $38\frac{1}{4}$ -	+0·00009702	0·25009702
„ $38\frac{1}{4}$ – $38\frac{1}{2}$ -	–0·00025350	0·24974650
„ $38\frac{1}{2}$ – $38\frac{3}{4}$ -	–0·00003068	0·24996932
„ $38\frac{3}{4}$ – 39 -	+0·00009602	0·24999602
And half inch 38 – 38·5 -	–0·00015648	0·49984352
„ 38·5 – 39 -	+0·00006534	0·49996534

Verification of tenths of 39–40, and hundredths of 39·3–39·4.

7. *Verification of Tenths of Inch 39–40, and Hundredths of 39·3–39·4.*

The tenths of inch 39·40 are not numbered on SS. The tenth 39·3–39·4 is divided into hundredths, and the defining line of the metre at 32° F. is continued through the space between the defining lines of 39·38 and 39·39, being 19 div. of micrometer No. 2, or 0·00060477 inch distant from 39·38.

Actual Comparisons on 2nd June 1870.

		Div.			Div.
Tenth - - -	39·0–39·1 =	3133	Tenth - - -	39·5–39·6 =	3131
„ - - -	39·1–39·2 =	3138	„ - - -	39·6–39·7 =	3133
„ - - -	39·2–39·3 =	3136	„ - - -	39·7–39·8 =	3134
„ - - -	39·3–39·4 =	3131	„ - - -	39·8–39·9 =	3130
„ - - -	39·4–39·5 =	3132	„ - - -	39·9–40·0 =	3139

Results of Comparisons.

Compared Tenth.	Comparing Tenth.	Difference of compared		Ascertained Error of compared Tenth.	Standard Length of compared Tenth.
		In Div.	In Inch.		
				In.	In.
39·0–39·1 -	- -	—	—	–0·00002806	0·09997194
39·1–39·2 =	39·0–39·1 -	+5	+0·00015915	+0·00013109	0·10013109
39·2–39·3 =	„ -	+3	+0·00009549	+0·00006743	0·10006743
39·3–39·4 =	„ -	–2	–0·00006366	–0·00009171	0·09990829
39·4–39·5 =	„ -	–1	–0·00003183	–0·00005988	0·09994012
39·5–39·6 =	„ -	–2	–0·00006366	–0·00009171	0·09990829
39·6–39·7 =	„ -	—	—	–0·00002804	0·09997196
39·7–39·8 =	„ -	+1	+0·00003183	+0·00000377	0·10000377
39·8–39·9 =	„ -	–3	–0·00009549	–0·00012353	0·09987647
39·9–40·0 =	„ -	+6	+0·00019098	+0·00016282	0·10016282
Here 10 (39·0–39·1) = Inch 39–40			–0·00022281		
Ascertained error of „			–0·00005782	–0·00005782	0·99994218 = Inch 39–40.
„ of 10 (39–39·1) -			–0·00028063		
Consequently half inch 39–39·5 -				+0·00001887	0·50001887
„ „ 39·5–40 -				–0·00007669	0·49992331

Appendix VII.—*continued.*

Comparison of Hundredths of 39·3–39·4.

		Div.			Div.
Hundredth - -	39·30–39·31 =	309	Hundredth - -	39·35–39·36 =	316
" - -	39·31–39·32 =	319	" - -	39·36–39·37 =	316
" - -	39·32–39·33 =	313	" - -	39·37–39·38 =	311
" - -	39·33–39·34 =	312	" - -	39·38–39·39 =	317
" - -	39·34–39·35 =	312	" - -	39·39–39·40 =	307

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth.	
		In Div.	In Inch.			
				In.	In.	
39·30–39·31 -	-	—	—	−0·00014286	0·00985714	
39·31–39·32 =	39·30–39·31	+10	+0·00031830	+0·00017544	0·01017544	
39·32–39·33 =	"	+ 4	+0·00012732	−0·00001554	0·00998446	
39·33–39·34 =	"	+ 3	+0·00009549	−0·00004735	0·00995265	
39·34–39·35 =	"	+ 3	+0·00009549	−0·00004735	0·00995265	
39·35–39·36 =	"	+ 7	+0·00022281	+0·00007995	0·01007995	
39·36–39·37 =	"	+ 7	+0·00022281	+0·00007995	0·01007995	
39·37–39·38 =	"	+ 2	+0·00006366	−0·00007920	0·00992080	
39·38–39·39 =	"	+ 8	+0·00025464	+0·00011178	0·01011178	
39·39–39·40 =	"	− 2	−0·00006366	−0·00020653	0·00979347	
Here 10 (39·30–39·31) = Tenth 39·3–39·4			−0·00133686			
Ascertained error of "			−0·00009171	−0·00009171	0·09990829	=Tenth 39·3–39·4.
" of 10 (39·30–39·31) -			−0·00142857			

8. *Verification of Halves, Quarters, Eighths, and Sixteenths* (*or Nails*) *of the Yard SS.*

Verification of halves, quarters, eighths, and sixteenths or nails, of SS.

The standard SS. is also subdivided into 16 parts or nails (2¼ inches), each nail division being respectively distinguished by the figures $\frac{1}{16}$, $\frac{2}{16}$, $\frac{3}{16}$, $\frac{4}{16}$, $\frac{5}{16}$, $\frac{6}{16}$, $\frac{7}{16}$, $\frac{8}{16}$, $\frac{9}{16}$, $\frac{10}{16}$, $\frac{11}{16}$, $\frac{12}{16}$, $\frac{13}{16}$, $\frac{14}{16}$, $\frac{15}{16}$, engraved on the bar.

It may be noticed that the nail is much used as a measure of length in the cloth trade. In the comparisons the mean of 36 readings was in each case taken.

The verification of the two halves and the four quarters of the yard has been effected by comparing each of the four quarters of the yard (or length of four nails) with the length of nine inches on the slider S. Each nail of the series of four nails has then been verified from the ascertained amount of their total length. Microscopes Nos. 1 and 4 were used for the comparisons of the four quarters of the yard, and Nos. 3 and 4 for comparing the nails.

Actual Comparisons.

Number.	Date of Comparison.	Compared Standard.	Comparing Standard.	Difference of compared Standard in Divisions of Micrometers 3 and 4.	Difference in parts of an Inch.
(1)	July 19, 1870 -	Quarter yard 0 ... $\frac{4}{16}$ =	0·9 in. S. -	−5·52	−0·00019607
(2)	" - -	" $\frac{4}{16}$ ... $\frac{8}{16}$ =	" -	−4·17	−0·00014931
(3)	" - -	" $\frac{8}{16}$ ... $\frac{12}{16}$ =	" -	−7·61	−0·00024946
(4)	" - -	" $\frac{12}{16}$ ... $\frac{16}{16}$ =	" -	−12·05	−0·00041731
(5)	June 14 - -	Nail 0 ... $\frac{1}{16}$ =	0·25 to 2 in. S.	−6·8	−0·00024633
(6)	" - -	" $\frac{1}{16}$ ... $\frac{2}{16}$ =	" -	−7·4	−0·00025540
(7)	" - -	" $\frac{2}{16}$ ... $\frac{3}{16}$ =	" -	−9·1	−0·00030626
(8)	" - -	" $\frac{3}{16}$ ... $\frac{4}{16}$ =	" -	−7·5	−0·00027132
(9)	" - -	" $\frac{4}{16}$ ... $\frac{5}{16}$ =	" -	−4·0	−0·00016568
(10)	" - -	" $\frac{5}{16}$ ... $\frac{6}{16}$ =	" -	−6·8	−0·00024368
(11)	" - -	" $\frac{6}{16}$ ... $\frac{7}{16}$ =	" -	−4·4	−0·00016814
(12)	" - -	" $\frac{7}{16}$ ... $\frac{8}{16}$ =	" -	−4·2	−0·00015574
(13)	June 16 - -	" $\frac{8}{16}$ ... $\frac{9}{16}$ =	" -	−4·0	−0·00015766
(14)	" - -	" $\frac{9}{16}$ ... $\frac{10}{16}$ =	" -	−5·7	−0·00021107
(15)	" - -	" $\frac{10}{16}$ ... $\frac{11}{16}$ =	" -	−2·8	−0·00011262
(16)	" - -	" $\frac{11}{16}$ ... $\frac{12}{16}$ =	" -	−4·7	−0·00019197
(17)	" - -	" $\frac{12}{16}$ ... $\frac{13}{16}$ =	" -	−2·2	−0·00008642
(18)	" - -	" $\frac{13}{16}$ ... $\frac{14}{16}$ =	" -	−4·8	−0·00020795
(19)	" - -	" $\frac{14}{16}$ ... $\frac{15}{16}$ =	" -	−5·2	−0·00020194
(20)	" - -	" $\frac{15}{16}$ ... $\frac{16}{16}$ =	" -	−9·6	−0·00033424

Appendix VII.—*continued.*

Reduction of Comparison of Quarters of Yard SS.

Compared Quarter.	Comparing Quarter.	Difference of compared		Ascertained Error of compared.	Standard Length of compared Quarter Inches.
		In Div.	In Inch.		
SS. 0 ... $\frac{4}{16}$		—	—	+0·00003434	9·00003434
From (1) (2) SS. $\frac{4}{16}$ ... $\frac{8}{16}$ =	SS. 0 ... $\frac{4}{16}$	+1·35	+0·00004676	+0·00008111	9·00008111
„ (2) (3) „ $\frac{8}{16}$ ... $\frac{12}{16}$ =	„	−2·09	−0·00005339	−0·00001905	8·99998095
„ (3) (4) „ $\frac{12}{16}$ ... $\frac{16}{16}$ =	„	−6·53	−0·00022124	−0·00018690	8·99981310
Here 4 (0 ... $\frac{4}{16}$) = yard S.			+0·00022787		
Ascertained error of „ =			−0·00009050	−0·00009050	35·99990950
„ of 4 (0 ... $\frac{4}{16}$) =			+0·00013737		
∴ Ascertained error of 0 ... $\frac{4}{16}$ =			+0·00003434		
∴ Half yard 0 ... $\frac{8}{16}$ =				+0·00011545	18·00011545
Ditto $\frac{8}{16}$ ... $\frac{16}{16}$ =				−0·00020595	17·99979405

Reduction of Comparison of Sixteenths of Yard, or Nails, of SS.

—	Difference.	Ascertained Error.	Standard Length.
	Div.	In.	In.
$\frac{0}{16}$ - $\frac{1}{16}$ SS. =	—	+0·00003208	2·25003208
From (5) (6) $\frac{1}{16}$ - $\frac{2}{16}$ = $\frac{0}{16}$ - $\frac{1}{16}$ SS.	−0·00000907	+0·00002301	2·25002301
„ (6) (7) $\frac{2}{16}$ - $\frac{3}{16}$ = „	−0·00005993	−0·00002785	2·24997215
„ (7) (8) $\frac{3}{16}$ - $\frac{4}{16}$ = „	−0·00002499	+0·00000710	2·25000710
Whence 4 ($\frac{0}{16}$ - $\frac{1}{16}$) = $\frac{0}{16}$ - $\frac{4}{16}$	+0·00009399		
„ $\frac{0}{16}$ - $\frac{4}{16}$ = $\frac{1}{4}$ yard	+0·00003434	—	9·00003434
Therefore 4 ($\frac{0}{16}$ - $\frac{1}{16}$) = „	+0·00012833		
∴ $\frac{0}{16}$ - $\frac{1}{16}$ = 1 nail	+0·00003208		
$\frac{4}{16}$ - $\frac{5}{16}$ SS.	—	+0·00003791	2·25003791
From (9) (10) $\frac{5}{16}$ - $\frac{6}{16}$ = $\frac{4}{16}$ - $\frac{5}{16}$ SS.	−0·00007800	−0·00004009	2·24995991
„ (10) (11) $\frac{6}{16}$ - $\frac{7}{16}$ = „	−0·00000246	+0·00003545	2·25003545
„ (11) (12) $\frac{7}{16}$ - $\frac{8}{16}$ = „	+0·00000994	+0·00004785	2·25004784
Whence 4 ($\frac{4}{16}$ - $\frac{5}{16}$) = $\frac{4}{16}$ - $\frac{8}{16}$	+0·00007052		
$\frac{4}{16}$ - $\frac{8}{16}$ = $\frac{1}{4}$ yard	+0·00008111	—	9·00008111
Therefore 4 ($\frac{4}{16}$ - $\frac{5}{16}$) = „	+0·000015163		
∴ $\frac{4}{16}$ - $\frac{5}{16}$ = 1 nail	+0·000003791		
$\frac{8}{16}$ - $\frac{9}{16}$ SS.	—	+0·00000591	2·25000591
From (13) (14) $\frac{9}{16}$ - $\frac{10}{16}$ = $\frac{8}{16}$ - $\frac{9}{16}$ SS.	−0·00005341	−0·00004750	2·24995250
„ (14) (15) $\frac{10}{16}$ - $\frac{11}{16}$ = „	+0·00004504	+0·00005094	2·25005094
„ (15) (16) $\frac{11}{16}$ - $\frac{12}{16}$ = „	−0·00003431	−0·00002840	2·24997160
Whence 4 ($\frac{8}{16}$ - $\frac{9}{16}$) = $\frac{8}{16}$ - $\frac{12}{16}$	+0·00004268		
$\frac{8}{16}$ - $\frac{12}{16}$ = $\frac{1}{4}$ yard	−0·00001905	—	8·99998095
Therefore 4 ($\frac{8}{16}$ - $\frac{9}{16}$) = „	+0·00002363		
∴ $\frac{8}{16}$ - $\frac{9}{16}$ = 1 nail	+0·00000591		

Appendix VII.—*continued.*

—	Difference.	Ascertained Error.	Standard Length.
$\frac{12}{16} - \frac{13}{16}$ SS. - - - -	—	+0·00007449	2·25007449
From (17) (18) $\frac{13}{16} - \frac{14}{16} = \frac{12}{16} - \frac{13}{16}$ - - -	−0·00012153	−0·00004704	2·24995296
„ (18) (19) $\frac{14}{16} - \frac{15}{16}$ = „ - - -	−0·00011552	−0·00004103	2·24995897
„ (19) (20) $\frac{15}{16} - \frac{16}{16}$ = „ - - -	−0·00024782	−0·00017332	2·24982668
Whence 4 $(\frac{12}{16} - \frac{13}{16}) = \frac{12}{16} - \frac{16}{16}$ - - -	+0·00048487		
$\frac{12}{16} - \frac{16}{16} = \frac{1}{4}$ yard - - -	−0·00018690	—	8·99981310
Therefore 4 $(\frac{12}{16} - \frac{13}{16})$ = „ - - -	+0·00029797		
∴ $\frac{12}{16} - \frac{13}{16}$ = 1 nail - - -	+0·00007449		

Proof—

In. In.

Here $\frac{0}{16} - \frac{12}{16}$ or $\frac{3}{4}$ yard SS. - - = 27·000009640

And it has previously been found—

1 foot 0–12 inch = 11·99997005

1 foot 12–24 = 11·99997985

3 in. 24–27 = 3·00026044

Whence 27 in. 0–27, or $\frac{3}{4}$ yard SS. ———— 27·00021034

Difference 0·00011394 or about 3 divisions of the micrometer.

Verification of the Standard divided Inch D.

Verification of divided inch D.

This inch measure has already been mentioned at p. 98, App. VII. It has now been verified by comparison with the inch 36–37 of SS.

Comparison by Mr. Chisholm and Mr. Chaney, 21st June 1870, with Micrometer No. 3 and No. 4.

Div.

Mean of 12 readings D = 36–37 of SS. −2·3

„ +0·8

„ −2·0

Mean of 36 readings D = 36–37 of SS. −1·2 or −0·00000558 inch.

36–37 of SS. = 0·99987273

∴ Divided inch D = 0·99986715 or −0·00013285 inch.

Comparison of Tenths of divided Inch D.

The tenths of the divided inch D were compared on 13th July 1870 with microscope No. 2. Each tenth is numbered on the short bar D by small figures, 0–10. As these tenth of an inch are not subdivided (except tenth 0–0·1), it was found necessary to use the whole length of the micrometer screw, or that part of the rack teeth numbered 10–40, as it is not possible to bring two of the official microscopes sufficiently close together to permit of the ordinary mode of comparison.

Tenth 0·0 − 0·1 = 333·2 divisions of micrometer No. 2.
„ 0·1 − 0·2 = 332·3 „ „
„ 0·2 − 0·3 = 333·5 „ „
„ 0·3 − 0·4 = 330·4 „ „
„ 0·4 − 0·5 = 334·9 „ „
„ 0·5 − 0·6 = 334·3 „ „
„ 0·6 − 0·7 = 329·3 „ „
„ 0·7 − 0·8 = 335·0 „ „
„ 0·8 − 0·9 = 333·7 „ „
„ 0·9 − 1·0 = 331·3 „ „

Appendix VII.—*continued.*

Results of Comparisons.

Compared Tenth.	Comparing Tenth.	Difference of compared Tenth		Ascertained Error of compared Tenth.	Standard Length of compared Tenth.	
		In Div.	In Inch.			
				Inch.	Inch.	
0·0 − 0·1 =	- - -	—	—	−0·00000033	0·09999967	
0·1 − 0·2 =	0·0 − 0·1	−0·9	−0·00002865	−0·00002898	0·09997102	
0·2 − 0·3 =	„	+0·3	+0·00000955	+0·00000922	0·10000922	
0·3 − 0·4 =	„	−2·8	−0·00008812	−0·00008846	0·09991154	
0·4 − 0·5 =	„	+1·7	+0·00005411	+0·00005378	0·10005378	
0·5 − 0·6 =	„	+1·1	+0·00003501	+0·00003468	0·10003468	
0·6 − 0·7 =	„	−3·9	−0·00012414	−0·00012448	0·09987552	
0·7 − 0·8 =	„	+1·8	+0·00005729	+0·00005696	0·10005696	
0·8 − 0·9 =	„	+0·5	+0·00001591	+0·00001558	0·10001558	
0·9 − 1·0 =	„	−1·9	−0·00006048	−0·00006082	0·09993918	
Here 10 (0·0–0·1) = Inch D. -		-	+0·00012952			
Ascertained error of inch D. -		-	−0·00013285	−0·00013285	0·99986715	= Inch D.
„ „ of 10 (0·0 − 0·1) =			−0·00000333			

Comparison of Hundredths of divided Inch D.

The hundredths of the divided inch D were compared on 13th July 1870 with micrometer No. 2. The first tenth only of the divided inch D is subdivided, but the hundredths are not numbered. The measurements were made by readings of three hundredths consecutively, without moving the bar D under the microscope, so as to keep within the middle of the field.

Hundredth 0·00 − 0·01 = 314·1 divisions of micrometer No. 2.
„ 0·01 − 0·02 = 311·8 „ „
„ 0·02 − 0·03 = 317·9 „ „
„ 0·03 − 0·04 = 313·8 „ „
„ 0·04 − 0·05 = 314·1 „ „
„ 0·05 − 0·06 = 312·6 „ „
„ 0·06 − 0·07 = 313·6 „ „
„ 0·07 − 0·08 = 313·0 „ „
„ 0·08 − 0·09 = 313·3 „ „
„ 0·09 − 1·00 = 314·3 „ „

Results of Comparisons.

Compared Hundredth.	Comparing Hundredth.	Difference of compared Hundredth		Ascertained Error of compared Hundredth.	Standard Length of compared Hundredth.
		In Div.	In Inch.		
				Inch.	Inch.
0·00 − 0·01 =	- - -	—	—	+0·00000892	0·01000892
0·01 − 0·02 =	0·00 − 0·01	−2·3	−0·00007321	−0·00006428	0·00993572
0·02 − 0·03 =	„	+3·8	+0·00012095	+0·00012987	0·01012987
0·03 − 0·04 =	„	−0·3	−0·00000955	−0·00000062	0·00999938
0·04 − 0·05 =	„	—	—	+0·00000892	0·01000892
0·05 − 0·06 =	„	−1·5	−0·00005774	−0·00004881	0·00995119
0·06 − 0·07 =	„	−0·5	−0·00001591	−0·00000699	0·00999301
0·07 − 0·08 =	„	−1·1	−0·00003501	−0·00002609	0·00997391
0·08 − 0·09 =	„	−0·8	−0·00002546	−0·00001654	0·00998346
0·09 − 0·10 =	„	+0·2	+0·00000637	+0·00001529	0·01001529
Here 10 (0·00–0·01) = Tenth 0·0–0·1			+0·00008956		
Ascertained error of „ =			−0·00000033	−0·00000033	or 0·09999967
			+0·00008923		

Standards Office,
15th July 1870.

H. W. CHISHOLM,
Warden.

APPENDIX VIII.

PAPER DELIVERED by the WARDEN of the STANDARDS.—On the GAS-MEASURING STANDARDS.

I.—REVERIFICATION of OFFICIAL GAS-MEASURING STANDARDS.

CONTENTS.

Page
Introductory remarks - - - - - - 127
  Normal temperature and barometric pressure in comparisons of gas-measuring Standards - - „
  Effect of aqueous vapour in air - - - „
  Question of absorption of air by water - - „
  Corrections for temperature and barometric pressure - 128
  Expansion of air - - - - - „
  Regnault's co-efficient of expansion adopted - - „
  Table (I.) of expansion of air or gas by heat - - „
  Atmospheric pressure on volume of gas - - 129
  Mode of observing barometers - - - „
  Elasticity of aqueous vapour in air - - - „
  Regnault's condenser hygrometer - - - „
  Table (II.) of elastic force of aqueous vapour - 130
  Table (III.) of increase of volume of air by moisture „
  Reductions to volumes of dry air - - - 131
Description of standards of gas measure - - - „
Standard cubic foot bottle - - - - - „
Mr. G. Glover's apparatus for filling it with water - - „
New cubic foot bottle and apparatus now being constructed by Mr. W. Sugg - - - - - - „
Gas-measuring Standards, 1, 5, and 10 cubic feet - - „
Page
Principles of construction - - - - - 131
Mode of construction - - - - - „
Special thermometers used with them - - - 132
Form of gas-measuring Standards - - - „
Graduated scales marked upon them - - - „
Scale readings of the gas-measuring Standards - - „
Original verification of standards of gas measure - - 133
  Standard cubic foot bottle - - - - „
  Three copies of the standard cubic foot bottle - „
  Gas-measuring Standards of 1, 5, and 10 cubic feet - „
  No verification made of subdivisions of the cubic foot „
Re-verification of standard cubic foot bottle - - „
  Do. do. No. 2 134
Re-verification of gas-measuring Standards of 1, 5, and 10 cubic feet - - - - - - - „
  Observations of temperature - - - - „
  And of pressure, indicated by the barometer and pressure gauge - - - - - 135
Actual comparisons and results - - - - „
Copy of official directions for verifying local standard gas measures - - - - - - - 136

Introductory remarks.

THE standard measures furnished to the Standards Department, in pursuance of the Sale of Gas Act, 1859, 22 & 23 Vict. c. 66, and intended as means for preventing frauds and errors in the sale of gas to the public, are measures of capacity, or rather of volume. They are applicable to the measurement, not only of volumes of coal gas, but also of volumes of air and gases of all kinds.

The following remarks upon the subject of corrections for expansion of gas or air by heat, and for atmospheric pressure, and elastic force of aqueous vapour, may serve as introductory to the account of the reverification of the standards of gas measure. They have been revised and corrected by me, but were in the first instance drawn up by Mr. Chaney, who has given much time and attention to the gas-measuring Standards, and has personally conducted all the operations for their reverification.

Corrections for Expansion by Heat, Atmospheric Pressure, and Elastic Force of Aqueous Vapour.

Normal temperature and barometric pressure, in comparisons of gas-measuring Standards.

Before proceeding with the reverification of the official gas-measuring Standards, which were deposited in this Department in 1861, in pursuance of the Sale of Gas Act, 1859, it may be desirable to state the normal temperature and barometric pressure in terms of which the capacity of these Standards is to be expressed.

By the provisions of the Act, the legal unit of measurement for the sale of gas is declared to be the cubic foot, containing 62·321 lbs. of distilled water, weighed in air, at the temperature of 62° Fahr., and the barometric pressure of 30 inches; and at this temperature and pressure the standard weight of 62·321 lbs. has been recently officially reverified.

There is no specific mention in the Sale of Gas Act of the temperature and barometric pressure at which the several gas-measuring Standards are to be verified. But as they constitute measures of parts and multiples of the standard cubic foot, being verified by comparison with this standard unit, it necessarily follows that their capacities must also be ascertained at the temperature (62° Fahr.) and barometric pressure (30 inches) at which the standard cubic foot is determined.

Effect of aqueous vapour in air.

The volume of air measured by these Standards being affected, however, not only by heat and atmospheric pressure, but also by the elastic force of the aqueous vapour contained in the air, it becomes necessary to state whether the unit of measurement is that of a volume of dry or desiccated air, or of a volume of air more or less moist, or of saturated air, or air at its maximum density. In explanation of the terms air, and gas, used in this paper, it may be here stated that air alone is used in the reverification of the official gas-measuring Standards. It was found that the temperature and other circumstances of the coal gas supplied by the local gas-lighting company varied too much to permit of its satisfactory use. In all the official comparisons made with the gas-measuring Standards, the air used is that of the gas-measuring room, which is not heated or lighted artificially, when the gas-measuring Standards are in use, the collected air in the bell of the standard always remaining over water.

Considering that the air measured by the official Standards, and also by the local standards, is thus in contact with water, and that all gas-measuring instruments used for commercial purposes indicate the measure of gas saturated with aqueous vapour, the unit of measurement in which the capacity of the official Standards is to be expressed ought consequently to be that of a volume of saturated air or air at its maximum density ($t = 62°$ $b = 30$ inches).

Question of absorption of air by water.

As all water contains a small amount of air in solution, it may be also necessary to consider whether the amount of air absorbed by water affects the reverification of the gas-measuring Standards. The amount of this absorption at different temperatures, and under various pressures, has been carefully ascertained by Dr. Henry, and more particularly by R. Bunsen.* Bunsen took as the mean mixture or composition of the air—

Oxygen	-	0·2096 = O
Nitrogen	-	0·7094 = N
		1·0000

and determined from this mixture the "co-efficient of absorption" of air, or the numerical expression of its solubility in water freed from air, at a particular

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* Gasometrische Methoden, Braunschweig, 1857.

Appendix VIII.—*continued.*

temperature and pressure. Bunsen found that at 32° Fahr. the volume of air dissolved in one volume of water is 0·02471, at 59° 0·01795. But the difference of the air absorbed at intermediate temperatures will not affect the absolute capacities of the gas-measuring Standards; the water over which the air is measured in the official standards is necessarily exposed to the air some time before the gas measures are used, and cannot therefore be considered as water freed from air. The air contained within the gas-measurers being similar to the air in the room, no change of volume by the diffusion of gases will affect the capacities of these Standards.

Corrections of temperature and barometric pressure.

The unit of measurement being determined, attention may next be drawn to the amount of correction to be made for temperatures and pressures other than the normal temperature and barometric pressure.

In 1861 the Astronomer Royal supplied the Exchequer Office with a table representing the dilatation of gas in contact with water and saturated with aqueous vapour, *for given temperatures.* This table shows the per-centage of increase of the volume of air above 31° ·4 Fahr. It is based upon tables of factors supplied by J. Glaisher, F.R.S., and is stated by the Astronomer Royal to be compiled in accordance with the best modern theories.

This table, which is always used in the official verification of local standards for the use of inspectors of gas meters, is as follows:—

Temperature in Fahrenheit's Scale.	Per-centage of Dilatation.	Temperature in Fahrenheit's Scale.	Per-centage of Dilatation.
31·40	0	65·63	8½
33·54	0½	67·43	9
35·70	1	69·18	9½
37·84	1½	70·90	10
39·91	2	72·60	10½
42·05	2½	74·30	11
44·17	3	75·94	11½
46·22	3½	77·23	12
48·25	4	78·81	12½
50·32	4½	80·40	13
52·36	5	81·94	13½
54·33	5½	83·44	14
56·24	6	84·88	14½
58·12	6½	86·39	15
60·02	7	87·83	15½
62·00	7½	89·20	16
63·77	8		

But this table was never intended to be applied in the reverification of the official Standards, for which more detailed corrections are required in the calculation of their absolute capacities.

Expansion of air.

Expansion of air.—A statement of the several investigations which have been made into the expansion of air is given by M. Jamin.[*]

The results of the earlier experiences, made by Gay Lussac, were, that all gases dilated equally, that their dilatation is independent of their pressure, and that the amount of expansion of all gases from 0° to 100° C. is 0·375, the co-efficient for 1° C. being 0·00375. The first and second of these statements has been shown by Regnault and others to be not strictly accurate, when applied to different gases under high temperatures, or at temperatures higher than the ordinary temperature of the atmosphere. The co-efficient of expansion of air has also been ascertained by the subsequent experiences of Dulong, Petit, and Pouillet, to be less than that stated by Gay Lussac.

Rudberg afterwards discovered several causes of error in the mode of manipulation adopted by previous investigators, and found the co-efficient of expansion of air for 1° C. to be 0·00365. But the most authoritative results yet attained are those derived from the elaborate experiments of M. Regnault, at Paris, and of M. Magnus, at Berlin.[†] By continuing the experiments of M. Rudberg, with improved means for ascertaining the relative expansions of air and of mercury, and from the use of instruments by which the air when heated was prevented from expanding, MM. Regnault and Magnus have independently arrived at similar results.

M. Regnault found the amount of expansion of air *under constant pressure* from 0° C, to 100° C, to be equal to 0·36706 of its volume at 0°[*], and that at 50° C. the mercurial thermometer was a little in advance of the air thermometer; the difference between the two thermometers at 50° being 0·2° C. Hence the expansion of air between 0° and 50°·2 C. is 0·18353 of its volume at 0°; or between 0° and 50° the ratio of the density of air at 0° to its density at t is $1+0·0036556\ t$. M. Magnus found that air under constant pressure expanded for 0° to 100° C. 0·36508.

When the volume of air *remained constant* M. Regnault determined the coefficient of its expansion to be 0·003665 for 1° C.

In explanation of the terms "constant volume" and "constant pressure," it may be stated that constant volume is when the pressure is augmented and the volume unchanged; constant pressure is when the gas is allowed to dilate to such an extent that its pressure remains unchanged.

Regnault coefficien of expans adopted.

Having regard to the mode in which the gas-measuring Standards are constructed, the barometric pressure being compensated and thus remaining unalterable with increase of temperature, and to the fact that the temperature of the air measured is ascertained by mercurial thermometers, which can be afterwards checked by comparison with Regnault's air thermometer, the equivalent of Regnault's coefficient of expansion of air under constant pressure, viz., 0·0020392 for 1° Fahr., may be adopted in reverifying the official gas-measuring Standards. The following table (Table I.), gives the calculation of $(1 \pm 0·00203922\ t)$.

Table I. Expansi of air or gas by h

TABLE I.—Expansion of Air or Gas by Heat.

Calculation of $(1 \pm 0·00203922\ t.)$

Temperature.	Volume.	Temperature.	Volume.
Faht.		Faht.	
50°	0·97552936	71°	1·01835298
51	0·97756858	72	1·02039220
52	0·97960780	73	1·02243142
53	0·98164702	74	1·02447064
54	0·98368624	75	1·02650986
55	0·98572546	76	1·02854908
56	0·98776468	77	1·03058830
57	0·98980390	78	1·03262752
58	0·99184312	79	1·03466674
59	0·99388234	80	1·03670596
60	0·99592156	81	1·03874518
61	0·99796078	82	1·04078440
62	1·00000000	83	1·04282362
63	1·00203922	84	1·04486284
64	1·00407844	85	1·04690206
65	1·00611766	86	1·04894128
66	1·00815688	87	1·05098050
67	1·01019610	88	1·05301972
68	1·01223532	89	1·05505894
69	1·01427454	90	1·05709816
70	1·01631376		

In ascertaining the temperature of the air in the gas-measuring Standards, it has been found that the method hitherto employed in the Standards Deparment of inserting a mercurial thermometer with a long bulb (2½ inches in length) in the *top* of the "bell" of the gas measures gave very erroneous results. The long bulb not only *dipped* in the water when the gas measures were emptied, but from the position of the thermometer in the top of the gas measure, the bulbs were always partly covered with *moisture.* New and more accurate thermometers having shorter bulbs, with consequently less bulk of mercury, have accordingly been obtained. The temperature has also been taken at the outlet of the gas measures as well as at the top of the "bell" of the gas-measuring Standard, to allow for the deposit of moisture on the bulbs of the thermometer inserted in the "bell."

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[*] Cours de Physique de l'Ecole Polytechnique, tom. I.

[†] Poggendorff's Annalen, IV., 1; Ann. Chim. Phys., 3rd Series, IV. 5, V. 52.

[*] Professor W. H. Miller's Report on the Construction of the Imperial Pound. Phil. Trans. 1856, p. 784.

Appendix VIII.—*continued.*

Atmospheric pressure on volume of gas.

Atmospheric pressure.—In the determination of the volume of gas by estimating the amount of atmospheric pressure to which it is subjected, the law known as Boyle's, or Mariotte's, law, by which the volume of a gas is declared to be inversely at the pressure to which it is subjected, the temperature remaining the same, is generally adopted. Expressed by a formula this law becomes $V = \frac{V^1 H^1}{H}$; V^1 being the observed volume of gas, V the corrected volume, H the normal height of the barometer, H^1 the observed height of the barometer. By the experiences of MM. Arago, Pouillet, and Regnault, this law has been found to be limited in its application and not theoretically exact, but it is stated that the divergencies (Jamin, t. I., p. 285) are so small that the law of Mariotte may still be employed in scientific operations at the ordinary temperature of the air.

Mode of observing barometers.

8. The atmospheric pressure of the air in the gas-measuring Standards is determined by the mean height of two barometers placed in contiguity with the Standard. It is also usual in laboratory experiments for determining the volume of gas, to allow for the difference of the two levels of the mercury, or water, over which the gas to be measured is collected; the water or mercury inside the collecting jar, or bell, being subjected to a pressure different to that experienced in the room and on the exterior of the collecting vessel; but in the official gas-measuring Standards no such allowance is required.

Elasticity of aqueous vapour in air.

Elasticity of aqueous vapour.—The volumes of gas or air contained in the bell of the standard, are affected by the aqueous vapour taken up by them, particularly when they are in contact with water, thus forming a mixture of greater volume than dry gas or air. The proportion of vapour in air, which is liable to considerable variation, may be ascertained by observing the temperature at which the air begins to deposit moisture, or the dew-point, and by the rapidity of evaporation. The psycrometrical instruments used by Prof. Daniell in ascertaining the dew-point,* and M. Regnault's condenser hygrometer, may be employed in determining the amount of moisture present in the volume of air measured by the official Standards.

The following diagram shows such a condenser hygrometer, which can be made by Deleuil, of Paris, for the use of this Department, a full description of this instrument being also contained in Professor Graham's Elements of Chemistry, vol. i., p. 96:—

Fig. 1.

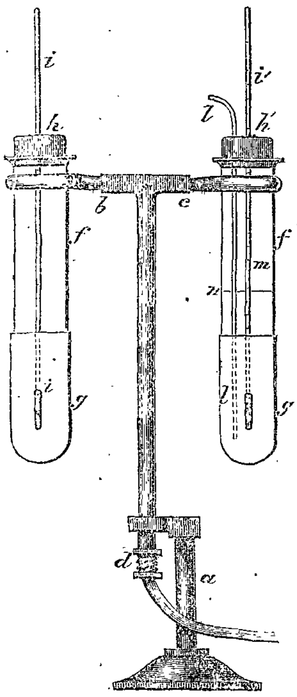
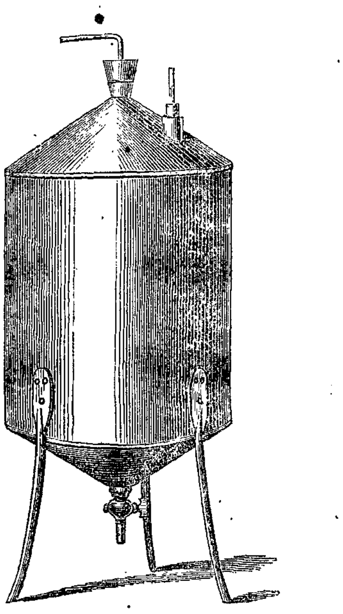


Fig. 2.



Scale, $\frac{1}{3}$ real size.

Fig. 1 represents the condenser hygrometer, and Fig. 2 a simple aspirator, for containing water, to be used if necessary in place of the gas measurer for regulating the supply of air to the hygrometer (Fig. 1). The hygrometer consists of the two glass tubes *f*, *f′*, attached to and connected by lateral openings with the glass tube *b*, *c*, *d*, which also has lateral openings at *b* and *c*; the whole being supported by the stand *a*. To the lower end of each tube *f*, *f′*, is tightly fitted a thin silver thimble *g*, *g′*, highly polished; the upper end of each tube being closed by a cork (*h*, *h′*). Each cork is perforated to receive a sensitive thermometer (*i*, *i′*). The cork of the tube *f′* which is nearest to the aspirator is also pierced to receive a very small glass tube *l*, which is open at both ends and descends to the bottom of the thimble. The tube *f′* with the thimble *g′* attached, being filled up to the line *n* with ether or alcohol, and the lower part of the tube *b*, *c*, *d*, being connected with the gas measurer or aspirator, either by elevating the gas measurer, or by allowing water to run from the aspirator, air is made to enter the tube *f′* through the small tube *l*, and to bubble up through the ether. The temperature of the ether is thus lowered, being recorded by the thermometer *i′*, and in less than a minute an abundant deposit of dew will be formed on the polished metallic surface of the thimble. By repeating this experiment, M. Regnault was enabled to determine the dew-point in three or four minutes within about 0·1° Fahr. The temperature of the air during the experiment is observed from the thermometer *i*, placed in the tube *f*, to which its silver thimble *g* is attached, but containing no ether.

As gas or air, when standing over water, becomes *saturated* with aqueous vapour,† the quantity of vapour being proportional to the temperature and barometric pressure, the amount of correction due to the aqueous vapour present in the air thus saturated during the reverification of the official gas measurers can be ascertained by the following Table (II.) of tension or elastic force of aqueous vapour in saturated air at various temperatures. This table gives the elastic force of vapour in inches of barometric pressure from 50 to 90 degrees of Fahrenheit's scale, and is equivalent to the table given by M. Regnault, as the results of his experiments on the force of steam.‡

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* Introduction to Chemical Philosophy, p. 154.

† Faraday's Chemical Manipulation, p. 388.

‡ Annales de Chimie et de Physique, 3° série, t. XI. p. 273; Mémoires de l'Institut de France, Vol. XXI.

Appendix VIII.—*continued.*

Table II. Elastic force of aqueous vapour.

Table II.—Elastic Force of Aqueous Vapour.

Temperature.	Force of Vapour.	Difference.	Temperature.	Force of Vapour.	Difference.
Faht.	Inch.	Inch.	Faht.	Inch.	Inch.
50°	0·36083		71°	0·75852	0·02536
51	0·37437	0·01354	72	0·78458	0·02606
52	0·38835	0·01398	73	0·81147	0·02689
53	0·40284	0·01449	74	0·83915	0·02768
54	0·41776	0·01492	75	0·86765	0·02850
55	0·43309	0·01533	76	0·89698	0·02933
56	0·44910	0·01601	77	0·92718	0·03020
57	0·46548	0·01638	78	0·95868	0·03150
58	0·48249	0·01701	79	0·99033	0·03165
59	0·49997	0·01748	80	1·02343	0·03310
60	0·51808	0·01811	81	1·05730	0·03387
61	0·53674	0·01866	82	1·09222	0·03492
62	0·55595	0·01921	83	1·12813	0·03591
63	0·57579	0·01984	84	1·16510	0·03697
64	0·59631	0·02052	85	1·20305	0·03795
65	0·61741	0·02110	86	1·24207	0·03902
66	0·63918	0·02177	87	1·28219	0·04012
67	0·66163	0·02245	88	1·32353	0·04134
68	0·68469	0·02306	89	1·36597	0·04244
69	0·70855	0·02386	90	1·40967	0·04370
70	0·73316	0·02461			

Professor W. H. Miller states that according to a document to which the names of Biot, Regnault, and Bianchi are attached, the pressure of vapour in rooms at Paris that are not heated artificially is two-thirds of the maximum pressure due to the temperature.

This proportion has been taken in the tables constructed by Professor Miller, and used in the Standards Department in the comparison of standard weights of different densities.

The following Table (III.) shows the dilatation of a volume of dry air after it has been saturated with aqueous vapour.* It has been prepared from the formula used by Mr. Glaisher,

$$n' = \frac{n}{1 - \dfrac{E_t}{p}}$$

n being a volume of dry air, n' the volume of air saturated with aqueous vapour, E^t the elastic force of vapour, and p the atmospheric pressure.

Table III. Increase of volume of air by moisture.

Table III.—Increase of Volume of Air by Moisture.

Temperature. Faht.	Increase of Volume of One Cubic Foot of Dry Air, when saturated, or at its maximum density.					
	Barometer = 29·5 Inches.		Barometer = 30·0 Inches.		Barometer = 30·5 Inches.	
	Volume.	Difference.	Volume.	Difference.	Volume.	Difference.
Faht.						
50°	1·01238		1·01217		1·01197	
51	1·01286	0·00048	1·01264	0·00047	1·01243	0·00046
52	1·01334	0·00048	1·01311	0·00047	1·01289	0·00046
53	1·01385	0·00051	1·01361	0·00050	1·01338	0·00049
54	1·01437	0·00052	1·01412	0·00051	1·01389	0·00051
55	1·01489	0·00052	1·01465	0·00053	1·01441	0·00052
56	1·01546	0·00057	1·01520	0·00055	1·01495	0·00054
57	1·01604	0·00058	1·01576	0·00056	1·01550	0·00055
58	1·01663	0·00059	1·01635	0·00059	1·01608	0·00058
59	1·01724	0·00061	1·01695	0·00060	1·01667	0·00059
60	1·01788	0·00064	1·01757	0·00062	1·01728	0·00061
61	1·01853	0·00065	1·01822	0·00065	1·01791	0·00062
62	1·01920	0·00067	1·01889	0·00067	1·01856	0·00065
63	1·01991	0·00071	1·01957	0·00068	1·01924	0·00068
64	1·02063	0·00072	1·02028	0·00071	1·01994	0·00070
65	1·02137	0·00074	1·02100	0·00072	1·02066	0·00072
66	1·02215	0·00078	1·02177	0·00077	1·02140	0·00074
67	1·02293	0·00078	1·02254	0·00077	1·02216	0·00076
68	1·02376	0·00083	1·02335	0·00081	1·02296	0·00080
69	1·02462	0·00086	1·02420	0·00085	1·02379	0·00083
70	1·02549	0·00087	1·02505	0·00085	1·02463	0·00084
71	1·02638	0·00089	1·02593	0·00088	1·02550	0·00087
72	1·02733	0·00095	1·02686	0·00093	1·02641	0·00091
73	1·02829	0·00096	1·02780	0·00094	1·02734	0·00093
74	1·02927	0·00098	1·02877	0·00097	1·02829	0·00095
75	1·03030	0·00103	1·02978	0·00101	1·02928	0·00099
76	1·03135	0·00105	1·03082	0·00104	1·03030	0·00102
77	1·03245	0·00110	1·03189	0·00107	1·03135	0·00105
78	1·03359	0·00114	1·03299	0·00110	1·03243	0·00108
79	1·03474	0·00115	1·03414	0·00112	1·03356	0·00113
80	1·03593	0·00119	1·03531	0·00117	1·03472	0·00116
81	1·03716	0·00123	1·03654	0·00123	1·03591	0·00119
82	1·03844	0·00128	1·03778	0·00124	1·03714	0·00123
83	1·03976	0·00132	1·03908	0·00130	1·03842	0·00128
84	1·04112	0·00136	1·04041	0·00133	1·03972	0·00130
85	1·04252	0·00140	1·04178	0·00137	1·04109	0·00134
86	1·04396	0·00144	1·04319	0·00141	1·04245	0·00139
87	1·04544	0·00148	1·04464	0·00145	1·04389	0·00144
88	1·04698	0·00154	1·04615	0·00151	1·04537	0·00148
89	1·04855	0·00159	1·04770	0·00155	1·04690	0·00153
90	1·05019	0·00164	1·04931	0·00161	1·04847	0·00157

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* Biot's Traité de Physique, tom. I.; Hygrometrical Tables by James Glaisher, F.R.S., 1869.

Appendix VIII.—*continued.*

Reductions o volumes f dry air.

In the determination of the volume of gases, R. Bunsen, in all his calculations, reduces the observed volumes of air to volumes of dry air at 0° C., under a pressure of 1 metre of mercury as follows:—

$$v' = \frac{(v+m)(b-b'-b'')}{(1+0\cdot00366t^\circ)}$$

In which v' is the corrected volume of dry gas; v represents the observed volume; b, the barometric pressure; b', the height of the column of mercury rising from the level of the trough into the eudiometer; b, the tension of aqueous vapour according to Regnault's tables; t, the observed temperature; m, the capillary elevation or depression; and $0\cdot00366t$, the coefficient of expansion of air at a constant volume. In the re-verification of the gas-measuring Standards, no allowance for differences of barometric pressure (b') in the bell or trough, or for capillarity (m) is required. The correction (m) for the error of the barometer reading is applied in the official operations before making calculations or corrections for barometric pressure. An example of Bunsen's calculation may be given as follows:*—

Measurement of air saturated with aqueous vapour, or of air at its maximum density—

$v=292\cdot7^{cc}$	log. $(v+m)=$	log. $293\cdot1$	$= 2\cdot46702$
$m=0\cdot4^{mm}$	+log. $(b-b'-b'')=$	log. $0\cdot4807=$	$\bar{0}\cdot68187-1$
$b=746\cdot9^{mm}$	+comp.log. $(1+0\cdot00366t)=$	comp.log. $1\cdot0739=$	$0\cdot96903-1$
$b'=248\cdot6^{mm}$		log. v'	$= 2\cdot11792$
$b''=17\cdot6^{mm}$		$\therefore v'$	$=131\cdot20^{cc}$
$t=20^\circ\cdot2$			

By actual experiment the same volume of air dried over chloride of calcium was found by Bunsen to be $v'=131\cdot26$ c.c.

In the comparison of the relative capacities of the several official gas-measuring Standards, and of the auxiliary standard cubic foot, the correction for atmospheric pressure being the same for both descriptions of Standards when placed in approximate positions, it will be only necessary to allow for difference of volume by heat and moisture. And in determining the absolute capacities of the gas-measuring Standards, their capacities should be ascertained at the standard temperature of 62° Fahr., and barometric pressure of 30 inches.

Description of standards of gas measure.

The official gas-measuring Standards required to be re-verified are as follows:—

The standard cubic foot measurer or bottle.
The 1 cubic foot gas-measuring Standard.
,, 5 ,, ,,
,, 10 ,, ,,

Standard cubic foot bottle.

The standard cubic foot measure was constructed by Mr. Ladd. It is a copper vessel or bottle, in shape a cylinder of 12 inches external diameter, with a cone at each end (see Fig. 1, p. 6). The cylinder is strengthened with a brass belt at the top and bottom. To the upper cone is attached a brass cylindrical neck, of $1\frac{5}{16}$ inch internal diameter, for the introduction of water, and which can be closed with a small glass disc, placed upon its plane rim. The lower cone has a smaller brass cylindrical tube attached to it, about ¼ inch internal diameter, fitted with a tap for discharging the water. This standard measure is constructed to contain 62·321 lb. weight of pure distilled water, this being the legal weight of a cubic foot of water at the temperature of 62° Fahr., the barometer being 30 inches. The weight of water is tested by the standard weight of 62·321 lb. provided for this purpose.

When this standard measure contains no water, it is intended to hold a cubic foot of air, and this measured quantity of air can be transferred to another measure, such as one of the gas-measuring Standards, for the purpose of determining its capacity. The weight of the standard cubic foot bottle somewhat exceeds 25 lbs.

Mr. G. Glover's apparatus for filling it with water.

A special apparatus has been furnished for filling the standard cubic foot with water. This apparatus (see Fig. 1, p. 6) was invented by Mr. G. Glover, in order that the nearly undisturbed surface of the water should be carried upwards and gradually through the entire height of the bottle, without risk of forming air bubbles. By the same process, the exact volume of air defined by the capacity of the bottle was intended to be transferred to a gas-measuring Standard.

This operation is effected by inverting the bottle, and placing it in position in the upper part of the apparatus, immediately over the cistern filled with water; withdrawing the plug or tap; closing the ends of the plug-hole at each side by pieces of glass fitting in spaces constructed for the purpose; securing a piece of india-rubber tubing to the end of the smaller cylindrical brass tube, and connecting this tube with the gas-measuring Standard. The cistern is then raised steadily, without the water being agitated, until the water reaches the point at which the plug, had it been retained, would have stopped it. The cubic foot bottle is thus exactly filled with water, and the entire volume of air which had been contained in it, being one cubic foot as defined by the capacity of the bottle, is transferred to the gas-measuring Standard.

New cubic foot bottle and apparatus, now being constructed by Mr. W. Sugg.

The new and improved cubic foot bottle and apparatus now being constructed for this Department by Mr. W. Sugg are similar to those used by the metropolis gas referees. They differ from the standard cubic foot measure and apparatus now used in the following particulars:—1. The cubic foot bottle is filled from a cistern placed *over* it. 2. The standard bottle is made of similar metal and density to the gas-measuring Standards. 3. It has a graduated glass neck. 4. It is provided with contrivances for preventing the accumulation of air bubbles inside the measure, and for noting the actual temperature of the air displaced. The necessity for this new apparatus is referred to on pages 8, 9 of this Paper.

Gas-measuring Standards of 1, 5, and 10.

The gas-measuring Standards were constructed by Messrs. Donkin, under the directions of the Astronomer Royal, who entrusted the superintendence of their construction to Mr. George Glover. The principles upon which they were constructed, and the mode of their construction, have been thus described by Mr. Glover:—

Construction of Standards of Gas Measure.

Principles of construction.

"In constructing a legal standard for the measurement of gas the highest attainable accuracy is required, and the following conditions were held to be essential:—

"1. That the instrument should be composed of anti-corrosive metal, capable of resisting the chemical action of the constituents of coal, gas, and water.

"2. That the surface of the bell should readily part with water.

"3. That the bell or measuring part of the instrument should be a truly cylindrical vessel, and sufficiently rigid to resist change of form from the application of any ordinary forces.

"4. That the bell should have a correct scale engraved upon it to indicate its capacity in cubic feet, and the subdivisions of the feet into minute fractional parts.

"5. That the bell should be correctly balanced, and that a part of the counterpoise, suspended by a cord passing over a spiral should preserve the equipoise of the bell at the various depths of its immersion in the water of the cistern.

"6. That the sides of the bell should be maintained vertical in its ascent and descent.

"7. That the taps should be lined with an anti-corrosive alloy, and the density of their rubbing surfaces be so varied as to reduce their friction to a minimum, and secure their durability and soundness.

"8. That the different parts of the instrument should be so perfectly adapted to each other, that, when put together as a whole, it should work easily, steadily, and correctly.

Mode of construction.

"The bell of the standard gas measures is made of a special alloy in which two metals mixed in determinate ratios are combined. Pure tin has been used with a small proportion of antimony. The alloy is made sufficiently malleable to allow its being rolled into a sheet, to be wrapped round a truly cylindrical mandril, and sufficiently ductile to allow the sheet lapped on the mandril to be drawn by steam power through a strong steel collar by which it is elongated, the surface being preserved unbroken and highly polished.

"This was found to be the only method by which truly cylindrical vessels could be made of anti-corrosive metal, adapted to the purpose of standard gas-measures.

"In soldering the seam, after the sheet was rolled on the mandril, a special method was adopted by which, when it had passed through the steel collar, it came out a perfect tube, it being impossible to discover where the joining had been made.

"A truly cylindrical vessel having been got, it is nicely equipoised, being connected by a steel band passing over a large wheel supported on friction rollers, a portion of the balance weight being attached to the distal end of a spiral which is fixed to the axle of the

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* Gasometry by R. Bunsen, translated by H. E. Roscoe, London, 1857, p. 38.

Appendix VIII.—*continued.*

wheel, and is itself balanced by a corresponding spiral on its opposite side.

"The tank of the gasometer is turned truly cylindrical on the upper third and lined with anti-corrosive metal, the lower two-thirds being enamelled.

"The bell is nicely balanced, and has two spirit levels on the top to show that it is maintained in a position truly vertical.

"The scale of the bell is cut on the bell itself, and can neither be removed nor tampered with."

Special thermometers.

The thermometers which were specially constructed for testing copies of the standard gas measures have elongated bulbs; on one side of the thermometer there is a scale for temperature; on the other a scale intended to be used for corrections rendered necessary by variations of temperature and moisture in the gas. As previously mentioned, the use of these thermometers with long bulbs has been since abandoned. A thermometer and pressure gauge are placed on the column at the inlet and outlet of each instrument when being tested.

Form of gas-measuring Standards.

The three gas-measuring Standards of the respective capacities of 1 cubic foot, 5 feet, and 10 feet, are precisely similar in form, differing only in size.

In the following drawings the forms are represented of,—

Fig. 1. The standard cubic foot bottle, with the apparatus for filling it with water.

Fig. 2. The standard 10 cubic feet gas measure.

Fig. 3. The solid table carrying the thermometers and pressure gauges, and other apparatus required to be used with the gas measurers. A pipe passing under the floor and up the leg of the table connects the thermometer bulbs and pressure gauges with the interior of the gas measurer. This arrangement of the thermometers and pressure guages on the slate table has not been found satisfactory. These instruments are intended to show the actual temperature and pressure of the air or gas in the "bell" of each standard; but it is found that owing to the length of pipe through which the air or gas has to travel from the "bell" under the floor to the slate table, that these instruments thus arranged do not indicate the precise temperature and pressure of the gas or air measured in the bell.

Gradua scales marked upon th

The scales on the 10 feet gas measurer are divided into feet, half-feet, tenth, and fiftieths of a cubic foot. Two-and-a-half of the smaller divisions ($\frac{2\frac{1}{2}}{50}$ cubic foot) being the limit of error allowed in local standards.

The scales on the 5 feet measurer are divided into feet, tenths, and hundredths of a cubic foot.

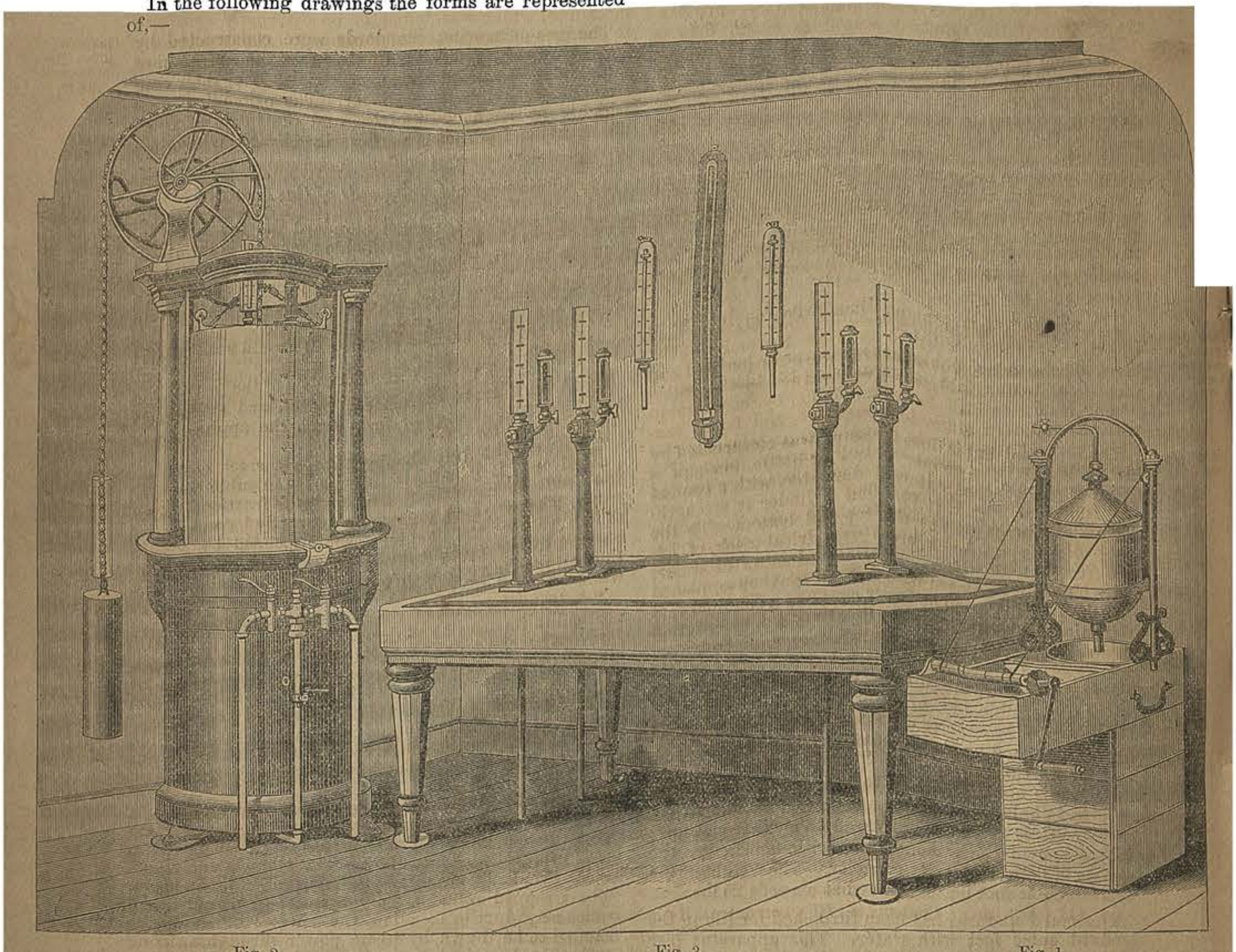

Fig. 2.
Standard 10-foot Gas Measurer.

Fig. 3.
Fixed table for Thermometers and Pressure Gauges connected with Gas Measures.

Fig. 1.
Standard Cubic-foot Bottle and Apparatus for filling.

The scales of the 1 foot measurer are divided into tenths, hundredths, and five-hundredths of a cubic foot.

The smallest quantity measured by each of the gas-measuring Standards is thus 0·002 ($\frac{1}{500}$) cubic foot by the 1 foot standard, 0·01 cubic foot by the 5 feet standard, and 0·02 cubic foot by the 10 feet standard. The smaller divisions may however be subdivided into tenths by means of a vernier fitted to the microscopes used in reading the scales, the scale of each standard being read by means of a microscope and hair, instead of the more uncertain method of using a metal pointer or band of metal.

Scale readings of the gas-measuring Standards.

As explanatory of the readings of the respective scales of the 10 feet, 5 feet, and 1 foot standard gas measures, it may be here stated that the scales are graduated so as to show the volume of air or gas passed *out of* or delivered from each gas measurer; the standard instruments being intended for use in passing measured volumes of air into copies, or local standards sent to the office for verification.

Appendix VIII.—*continued.*

The scales of the 10 feet and 5 feet are also graduated to register volumes of air received or passed into the standard when filling it.

The delivery graduation is on the left-hand side of each scale, the receiving or filling graduation being on the right-hand side of each scale.

Each gas measurer is provided with two scales, the scale on that side of the bell next to the taps or inlet pipe being called the *front* scale, the scale on the opposite of the bell being the *back* scale.

Each scale is extended one-tenth part beyond the register of the nominal capacity of the respective standards for the purpose of measuring differences in copies of the standards which are under comparison.

)riginal erification f standards f gas neasure.

All these standards of gas measure were originally verified at the Standards Office by the Astronomer Royal. There is no record in the books of the Department of the details of their verification, the only account being contained in the reports made to the Treasury by the Astronomer Royal, which were afterwards printed and laid before Parliament.

)f standard ubic foot ottle. Vo. 100 of 860.

The verification of the standard cubic foot bottle took place on the 14th and 15th November 1859, under the personal superintendence of the Astronomer Royal and Professor Miller, as stated in the Report dated 11th February 1860. It was made immediately after the verification of the standard weight of 62·321 lbs., a description of which has already been given in Appendix V. The cubic foot bottle was first attached to the scale beam when empty, and was counterpoised; was then filled with distilled water, and the standard 62·321 lbs. weight placed in the opposite scale; and the auxiliary weight required to be combined with or placed against the weight of 62·321 lbs., in order to produce equilibrium, was ascertained, the thermometer and barometer being observed and numerical corrections applied for the difference between their readings and the standard temperature and pressure. After this comparison had been satisfactorily made, the cubic foot bottle was declared a standard measure in the full meaning of the Act.

Three copies of standard cubic foot bottle.

No. 293 of 1860.

In addition to the standard cubic foot bottle, which was thus originally verified on 15th November 1859, three similar cubic foot measures were constructed and furnished by Mr. Ladd, and were verified by the Astronomer Royal on 13th February 1860, by comparison with the standard cubic foot measure, and found sensibly correct, the errors being within tolerance, as described in the Report of 15 February 1860. The errors tolerated, either in excess or defect, were limited to 0·5 cubic inch in the cubic foot.

These three copies of the standard cubic foot bottle were intended for distribution to the metropolitan cities of London, Edinburgh, and Dublin; but it was not considered requisite to send them, and they remained deposited in the Standards Department. They are of similar shape and material as the standard cubic foot bottle, but are distinguished from it by being engraved respectively "City of London, No. 2," "City of Edinburgh, No. 3," "City of Dublin, No. 4."

The official standard cubic foot bottle which has now been re-verified and used for the re-verification of the standard gas measures, is that distinguished as "City of London, No. 2." The cubic foot bottle engraved "City of Edinburgh" was lent to the metropolis gas referees upon their application of 23rd December 1868.

Of gas-measuring Standards.

No. 339 of 1861.

The account of the original verification of the three standard gas measures of 1, 5, and 10 cubic feet respectively, is contained in the Report of the 20th December 1860. These standards were verified on the 18th December by the Astronomer Royal, the volume of air defined by the cubic foot bottle being transferred to each gas measurer under comparison. For the one foot measurer, this operation was required, in strictness, only once, although, for the sake of precaution, it was repeated several times. For the 10 feet measurer, the cubic foot of air was necessarily transferred in ten successive operations.

The result of the examinations is stated to be that the 5 feet measurer exhibited no trace of error; that the 10 feet measurer appeared to show an error of about $\frac{1}{3000}$ part, which was considered to be undoubtedly due to a litttle change of temperature; and that the 1 foot measurer, which was found to be extremely sensitive to changes of temperature, apparently exhibited errors, sometimes + $\frac{1}{500}$, sometimes — $\frac{1}{500}$. Regarding these indications as merely illusory, the three gas-measuring Standards were reported to be as accurate as it was possible for human skill to make them, and as being to all intents and purposes perfect, and fit for the verification of gas measurers and gas meters of every class.

No verification made of subdivisions of cubic foot.

It may be seen that the intermediate parts or subdivisions of a foot on the graduated scales of these gas-measuring Standards were not verified by the Astronomer Royal. They have now only been verified to a certain extent by comparison one with another, as no means at present exist for accurately verifying these graduations by measuring their corresponding volumes, and their truth is now dependent upon the accuracy of the cylinder of which the bell is composed. These intermediate parts or subdivisions of the foot are not used in official comparisons, the entire capacities of local standards being alone tested.

Re-verification of the Standard Cubic Foot Bottle.

Re-verification of Standard Cubic Foot Bottle.

The capacity of the standard cubic foot bottle (SCF) has been re-verified by comparing the weight of its contents of distilled water, both with the combination of bullion standards used for the re-verification of the standard cubic foot weight, denoted as (B), and equivalent to 436,296·4511 grains, and also with the standard weight No. 1 of 62·321 lbs., now determined to be =436,247·39385 gr.

The following comparisons have been made with Ladd and Oertling's (formerly Kater's) large balances, six weighings having been taken for each comparison:—

Comparisons of Standard Cubic Foot Bottle, SCF.

No.	Date.	Weighings.	Difference of SCF in Divisions.	Value of One Division of Balance.	Difference of SCF in Grains.
	1869.		div.	gr.	gr.
(1)	Oct. 20 -	Contents of SCF ± correction ≏ B + bullion standards, 0·4, 0·05, 0·03, and 0·01 oz., or + 235·18248 gr.	+0·375	0·48001	+0·18000
(2)	,, 22 -	,, ,, ≏ B + grain weights, 200, 3, 2, 10 gr., or + 215·00306 gr.	−3·125	1·2307	−3·84606
(3)	Dec. 9 -	,, ,, ≏ standard weight No. 1 + bullion standards 0·3, 0·05, oz., or + 167·99145 gr.	−3·125	0·95992	−2·99975

Appendix VIII.—*continued.*

RESULTS OF COMPARISONS.

No.	Results of Weighings.	*t.*	*b.*	Correction for Temperature and Barometric Pressure.	Weight of Water in SCF at *t*= 62° Fahr. *b*=30 in.	Ascertained Error.
	gr.	Fahr.	ins.	gr.	gr.	gr.
(1)	SCF=436531·81399	53·65	30·194	−169·66380	436362·15019	or 115·15019 too heavy.
(2)	SCF=436507·30851	55·50	29·956	−144·95086	436362·65765	or 115·65765 „
				Mean -	436362·40392	115·40392 „
(3)	SCF=436418·38505	59·27	29·906	− 71·22913	436347·15592	or 100·15592 „

During comparison (3) several bubbles of air were seen on the neck of the bottle SCF, and this may account for the difference of somewhat less than 15 gr. between the result of (3), and the mean result of (1) (2); this mean result may therefore be accepted.

The weight of distilled water at the standard temperature and pressure contained in the standard cubic foot bottle has consequently been determined to be 62·337 lbs., or 436,362·40392 grs., being 0·016 lb., or 115·40392 grs. too heavy.

Re-verification of Standard Cubic Foot Bottle, No. 2.

COMPARISONS OF THE OFFICIAL STANDARD CUBIC FOOT BOTTLE, No. 2.

No.	Date of Comparison.	Weight of Water contained in Compared Cubic Foot Bottle.	Comparing Standard Weights.	Value of One Division of Balance.	Difference	
					in Divisions.	in Grains.
	1869.			gr.	div.	gr.
(1)	Nov. 15 -	Cubic foot + 0·5, 0·03, oz., (or + 254·38955 grs.)	≏ Bullion standards, 500, 400, 5, 3, 0·5, 0·3, 0·1, 0·05, 0·004 oz. (or 436296·45151 grs.)	0·533	−2·72	−1·453
(2)	„ 16 -	Cubic foot + 0·4, 0·02, 0·004, oz. (or + 203·51220 grs.)	≏ Do. do.	0·689	+0·38	+0·267

RESULTS OF COMPARISONS.

No.	Standard Compared.	Weight of Water contained in the Standard.	Barometer.	Thermometer Fahr.	Correction for Pressure and Temperature.	Weight of Water contained in the Standard t=62° Fahr. B=30 in.	Error of Standard.	Mean Error.	Mean Error in Cubic Inches.	Mean Error in Parts of Cubic Foot.
	Cubic Foot.	gr.	in.	°	gr.	gr.	gr.	gr.	gr.	gr.
(1)	Bottle No. 2	= 436549·48782	30·119	56·605	−124·22788	436425·15994	+178·15994	+160·15556	+0·63438	+0·000367
(2)	Do.	= 436500·23073	29·990	57·300	−111·17954	436389·15119	+142·15119			

Re-verification of Gas-measuring Standards of 1, 5, *and* 10 *Cubic Feet.*

Re-verification of gas-measuring Standards of 1, 5, and 10 cubic feet.

In re-verifying these standard measures the method adopted by the Astronomer Royal in the original verification of the standards of gas measure has been now followed. The standard 1 foot gas measurer was first compared with the standard cubic foot bottle No. 2 by transferring its volume of air. The standards of 5 feet and 10 feet were then in like manner compared with the 1 foot standard.

Observations of temperature;

In order to secure the greatest possible uniformity of temperature during the comparison of the gas-measuring Standards with each other and with the standard cubic foot, the water in the tanks of the gas measures, and in the cistern attached to the cubic foot apparatus, were constantly maintained, by means of hot and cold water properly mixed, at nearly the same temperature as the air in the gas room. And for observing the temperature of the air, measured with the greatest precision attainable, three new gas thermometers, Nos. 12,912, 12,913, 12,914, were obtained from Messrs. Negretti and Zambra. These instruments were tested at the Royal Observatory, and stated by the Astronomer Royal to be very fine and good thermometers. Notwithstanding, however, the precautions taken to keep the temperature of the two gas-measuring Standards under comparison at the same degree of heat, and the use of new sensitive thermometers and of screens, it will be seen by the numerical results of the comparisons that there was frequently a difference of 1° Fahr. in the temperature of the air in the two measures compared. This difference is not of any importance, as allowance has been made for it in the reduction of the results to standard temperature and pressure, and it only serves as an example to show the difficulty experienced in maintaining air at a uniform temperature.

Before any comparisons were made the room was kept for about six hours at the temperature of nearly 62°, so that the metal of which the gas measurers and their scales are made might be of like temperature; it having been found in the comparison of standard measures of length that nearly that time was occupied in properly bringing brass bars to the temperature of the surrounding air in the comparing box.

The present cubic foot apparatus does not afford the means of noting the temperature of the air inside the cubic foot bottle, and it was found by attaching a thermometer to the outlet of the bottle, that the temperature of the air inside, though drawn from the surrounding atmosphere, differed from the temperature of the air outside the bottle, which was probably con-

Appendix VIII.—*continued.*

stantly changed by sudden draughts and the movement of persons in the room. In the comparisons made with this apparatus, the temperature recorded is therefore the temperature of the outlet of the cubic foot apparatus and of the bell of the gas measurer.

In comparing the larger gas measurers (5 cubic feet and 10 cubic feet) with the cubic foot bottle, it would be proper to make allowance for the difference of expansion of the copper of which the standard cubic foot bottle is made, and the mixed white metal of which the gas measurers are composed, but as their coefficients of expansion have never been directly ascertained, no such allowance has been made.

The coefficient of cubic expansion of the copper bottle may be taken at 0·00002833 for 1° Fahr., that being the mean rate of expansion of wrought copper given by the Annuaire du Bureau des Longitudes. And the coefficient of cubic expansion of the white metal, which is composed principally of rolled and drawn tin, may probably be taken as 0·00003622 for 1° Fahr., according to the same authority.

and of pressure indicated by the barometer and pressure gauge.

When the taps of the outlet and inlet pipes of each gas measurer were open, so that the air in the bell was in free communication with the air in the room, each bell remained perfectly balanced at all parts of the scale, thus showing that the action of the cylindrical balance of the gas measurers was perfect, and that the barometers placed in the room correctly indicated the density of the air arising from atmospheric pressure in the gas measurers.

During the observations for re-verifying the gas-measuring Standards, two barometers were used, one placed in a plane with the lowest part of the bell, the other fixed at the highest point reached by the bell, and their mean reading of the atmospheric pressure was recorded.

In order to note the mechanical pressure arising in the comparison of two volumes of air enclosed in metallic vessels over water, the ordinary pressure gauge, consisting of water in a bent glass tube, was also used. In any further and more accurate re-verification of these gas-measuring Standards that may be required, these ordinary bent glass gauges will be supplemented by King's pressure gauge, three of which are now being constructed by Messrs. Wright and Co. for this Department. King's gauge divides half an inch (or other unit) of pressure, as shown by the column of water in the bent glass tube, into 150 parts, and it indicates gradations of pressure not shown by the bent tube gauge. When used to extend the scale readings of the ordinary water gauge, King's gauge is a sensitive and reliable instrument, but if used alone its readings are not uniform, owing to the friction of the machinery and displacement of the water employed in working it. It may be explained that King's pressure gauge consists of a metal cup floating in water, the surface of the water being exposed to the pressure of air or gas from the gas measurer to which the gauge is fitted; to the float is attached a cord suspended over a wheel, the spindle of which carries a pointer moving upon an index; any depression of the water-line in the gauge and consequent height of the float therefore causes a corresponding movement of the pointer.

As a rule a pressure of half an inch, as shown by the column of water, or 150°, as shown by King's gauge, was used to drive the air from one standard measure to another, but at the time of noting the comparative readings of the two standards the air was of course only exposed to the ordinary atmospheric pressure.

Comparisons of Standard Gas Measures of 1, 5, and 10 Cubic Feet.

Actual comparisons.

No.	Date.	Compared Standard.	Comparing Standard.	Difference of compared Standards.	Temperatures Fahrenheit.		Barometer.
					Compared.	Comparing.	
	1870.			Cubic foot.	°	°	°
(1)	March 7	1-foot Measurer =	Bottle No. 2	−0·00090	61·472	61·472	30·265
(2)	„ 8	„ „ =	„	−0·00096	61·052	61·052	30·235
(3)	„ 18	„ „ =	„	−0·00085	61·700	61·700	30·196
(4)	„ 11	5-feet Measurer =	(5) 1-foot Measurer	+0·00597	63·710	63·187	29·717
(5)	„ 12	„ „ =	„ „	−0·00235	63·086	63·104	29·623
(6)	„ 15	„ „ =	„ „	+0·00805	64·400	63·428	29·982
(7)	„ 17	„ „ =	„ „	+0·00495	63·842	63·104	29·000
(8)	„ 22	10-feet Measurer =	(10) 1-foot Measurer	−0·00210	63·500	63·014	29·758
(9)	„ 28	„ „ =	„ „	+0·00500	62·510	61·448	30·418

Results of Comparisons.

Their results.

No.	Difference of Compared Standard, at stated *t* and B.	Correction for Heat and Moisture.	Differences of Compared Standard, $t=62°$ B = 30 inches.	Mean Difference of Compared and Comparing.	Ascertained Error of Comparing Standard, $t=62°$ B = 30 inches.	Ascertained Error of Official Standard Gas Measures.
	Cubic Foot.	Cubic Foot.	Cubic Foot.	Cubic Foot.	Cubic Foot.	Cubic Foot.
(1)	−0·00090	—	−0·00090	−0·00090	+0·00037	−0·00053
(2)	−0·00096	—	−0·00096			
(3)	−0·00085	—	−0·00085			
(4)	+0·00597	−0·00929	−0·00332	−0·00402	−0·00265	−0·00667
(5)	−0·00235	+0·00018	−0·00217			
(6)	+0·00805	−0·01341	−0·00536			
(7)	+0·00495	−0·01021	−0·00526			
(8)	−0·00210	−0·01338	−0·01548	−0·01962	−0·00533	−0·02495
(9)	−0·00500	−0·02876	−0·02376			

Considering the purposes for which these gas-measuring Standards are required to be used, namely, the verification of copies of these standards for the use of the inspectors of gas meters, and that the allowance for error in the official verification of such local standards which is now adopted, having been proposed by the

Appendix VIII.—*continued.*

Astronomer Royal, and approved by the Treasury, is $\frac{1}{200}$ part of $\frac{1}{2}$ per cent., over or under, amounting to the following allowance for each denominator, viz.:—

1 foot gas-measuring Standard, 0·005 cub. ft., error allowed, in excess or deficiency.
5 foot gas-measuring Standard, 0·025 cub. ft., error allowed, in excess or deficiency.
10 foot gas-measuring Standards, 0·05 cub. ft., error allowed, in excess or deficiency.

The official gas-measuring Standards may be considered to be now in a satisfactory condition, and allowance may be made for the errors thus determined in all the Departmental comparisons; but so soon as the new apparatus is provided, further and final comparisons, particularly of the 10-feet standard, may be made, if such further verification should be thought desirable.

Official directions for verifying local standard gas measures.

As illustrating the mode of verifying the official gas-measuring Standards, the following directions for the official comparison and verification of local standard gas measurers, which are based upon the Astronomer Royal's original instructions in 1861 may be here given:—

1. *Position of the Instruments.*—The local standards to be compared is to be placed in proximity with the official standard, and in a position convenient for the reading of its scales. The two instruments are to be connected with flexible tubing. Care is to be taken that the connecting tubes afford clear communication, so that excessive friction in the pipes may be avoided. A truly vertical position of the compared standard is to be obtained.

2. *Water for Tanks.*—The tank of the compared standard is to be filled with water of similar temperature to that in the comparing standard, and the level of the water is to be adjusted when the bell is in its lowest position. In event of sufficient water not being in the cistern of the gas room for supplying the tanks of both instruments, they should remain filled with other water, and in the room for at least three hours before the test.

3. *Test of Mechanism of the Instrument.*—It should be ascertained that the mechanism of the local standard is of such kind as will work easily and correctly. Thus, the bell should not "bind" or "catch" in its passage up or down; it should be of cylindrical shape; the balancing weights should be divided into tenths and 1 in. water pressure.

4. *Scales.*—The local standard must have two scales, the one on the side next the taps or valves being called the front scale, and the other on the opposite side of the bell being called the back or rear scale. The scales are to be extended to one-tenth part beyond the register of their nominal capacity. This extension need not be tested or recorded.

5. *Test for Leakage.*—Gas is then to be admitted to the compared standard, a pressure of 3 ins. being maintained thereon, and a moveable flame is to be passed round the joints. This test of soundness may also be made by noticing the scales of the bell under trial as to whether they rise or fall, as shown by a fixed pointer.

6. *Test of the Cycloidal Balance.*—All communications being open whilst the bell of the compared standard is moved successively up to each foot or other division of the scale, it is to be ascertained that a perfect steadiness or equilibrium of the bell is sustained. Should the bell, when raised to any of the feet marked upon its scale, sink slightly, the variation in its position may be checked by placing small weights either on the bell itself or on its counterpoise balance, according as the bell rises or falls, always providing that such variation does not extend to more than 2 ozs. at the most.

7. *Comparison of Scales of Bell under Comparison.*—The front and back scales of the local standard are then to be compared. This test may also include the preceding (6) test of the "cycloidal balance." Any difference between the register of the front and back scales, or any fluctuations of the cycloidal balance are to be noted, and a mean of the difference between the two scales should always be taken as the true register of the capacity of the bell.

8. *Record of Comparisons.*—The results of the preceding tests, except otherwise directed, are to be noted in the record book with any remarks that may be thought necessary.

9. *Position of Bells.*—As a commencing trial of the whole capacity of the compared standard, the bell of the comparing standard may be placed nearly in its highest position, and the compared bell nearly in its lowest position. For example, with the standard scale at O, the copy would be placed at 10 (or 5 or 1 according to the size of the instruments).

10. *Observations of Temperature.*—The temperatures of the gas or air in the inlet and outlet pipes of the two standards and of their bells, are to be taken and recorded. Any variations between them are afterwards to be allowed for in recording the capacity of the bell under trial.

11. *Transfer of Air, or Gas, from one Bell to the other.*—A weight sufficient to act as a pressing or "driving weight" for forcing the contents from one bell to the other, is to be taken off the counterpoise balance of that bell which is full. Thus, in driving the contents of the comparing bell into the compared bell, a weight equivalent to $\frac{2}{10}$ or $\frac{3}{10}$ inch water pressure should be taken off the counterpoise of the official standard. The requisite volume of gas or air is then to be passed from one bell to another. Supposing the test to be that of the whole volume of a 10 cubic feet gas measurer, after having started from 10 the bell should be stayed at O. The "driving weight" is to be replaced after the passing of the requisite volume. This weight acting as a stop upon the passage of the gas or air, stays both bells simultaneously.

12. *Readings of Scales.*—The scales of the official graduated standard should be alone referred to as determining the register of the capacity of the bell under comparison. The means of the readings of the front and back scales of both standards are always to be taken.

13. *Application of Limit of Error.*—It is then to be ascertained that the difference, if any, between the two bells comes within the authorised limit of tolerance, such limits being as follows:—

Not exceeding either in excess or deficiency—
Two and a half of the smallest divisions on the 10-feet standard scale, or 0·05 cubic foot.
Two and a half of the smallest divisions on the 5-feet standard scale, or 0·025 cubic foot.
Two and a half of the smallest divisions on the 1-foot standard scale, or 0·005 cubic foot.

14. *Allowance for Dilatation.*—Allowance for any difference or variation between the temperatures of the interior of the bells of the two standards is to be made by applying the per-centages for dilatation given in the Astronomer Royal's Table, or the tables given in this paper. Thus, having transmitted a volume of gas or air from the official standard to the local standard with uniformity of temperature at the beginning of the operation, but an increase of temperature in the compared gas measurer at the end, the per-centage of error to be allowed for this excess of temperature, and consequent expansion of volume in the compared standard must be *deducted* from the observations of the compared standard. But on the other hand, with a decrease of temperature and consequent diminished volume in the compared standard, this per-centage should be added to the scale readings of the compared standard.

15. *Adjustment of Scales of Compared Standard.*—The scales of the compared standard should be adjusted so as to register a precise volume as having been passed, the difference, if any, between the two bells being determined as before stated by the scales of the comparing standard.

16. *Number of Observations.*—The operation of testing the whole capacity of the compared standard is to be repeated four times, or oftener as may be deemed necessary, and a mean of these trials is to be taken as the real capacity of the compared standard. Thus, the whole volume of gas or air being transferred in the first instance from the comparing to the compared standard, it may then be returned from the compared to the comparing standard, and this process can be repeated as often as requisite.

17. *Test of Subdivisions of Scales.*—The whole capacity of the compared standard (or the whole nominal length of its scale) having now been tested, and its correctness having been approved, the comparison of each separate foot or other subdivision of the scale is to be made. This operation is to be conducted under the same regulations as the test of the whole capacity, observing however to stop the scales at the requisite divisions. Thus, a 10-feet or 5-feet gasholder should be tested at each division of a foot, and a 1-foot at each tenth of a foot.

18. *Air to be used.*—In the testing of gasholders the use of air from the testing room is preferable to gas.

19. *Stamping or Sealing of Local Gas-Measuring Standards.*—A thin band of copper about 3 ins. in length, and $\frac{1}{4}$ in. in breadth, is to be fastened by solder and spirits of salts across that part of the scale not graduated. And a leather washer is to be placed in the rim of the "mould" of the sealing apparatus to prevent the escape of the metal. The component parts of a proper mixed metal for the seals, is as follows:—

Bismuth	5 parts.
Tin	4 „
Lead	4 „

The sealing metal is to be heated to a fusible state in a ladle. Sufficient metal for each operation only should be heated, as successive heating tends to throw off its hardening component, bismuth. Two persons are necessary for the operation of sealing. One to pour the fusible metal into the "gateway" of the mould of the apparatus, the other to press the seal against the metal on the bell. The sealing apparatus should be moderately heated to avoid too sudden a cooling of the sealing metal. As little metal to be used as possible, the metal being poured in the "gateway" of the mould should be pressed quickly by the seal. The seals are to be affixed to the copper band on each scale. Both the front and rear scales of each gasholder are to be sealed.

21. *Numbers of Compared Instruments.*—After the sealing, the number, in order of the verification, is to be stamped on the rim of the water tank over the exit and inlet taps in front of the instrument.

H. W. CHISHOLM,
Warden.

Standards Department,
Board of Trade,
2nd April 1870.

Appendix VIII.—*continued.*

II.—On the Proposed Construction and Use of Standard Test Gas Meters.

Contents.

Page
1. Introductory remarks by the Warden of the Standards, dated 26 July 1870 - - - - - 137
2. Mr. Cresy (of the Metropolitan Board of Works) to the Warden of the Standards, dated 15 July 1870 - „
3. From Mr. Airey, Inspector of Gas Meters in the Metropolitan District, dated 15 July 1870 - - - „
4. From Mr. Airey, Inspector of Gas Meters in the Metropolitan District, dated 26 July 1870 - - - „
5. Extract from "Gas Meter Testing under the Sale of Gas Act," by F. W. Hartley - - - - 139
6. Mr. Hartley to the Warden of the Standards, with specification of Standard Wet Gas Meter to pass 5 cubic feet at one revolution; dated 16 July 1870 - 140
7. Mr. Hartley to the Warden of the Standards, with specification of Standard Wet Gas Meter to pass one cubic foot at one revolution, and stating advantages of Test Wet Gas Meters; dated 22 July 1870 - - 141

Page
8. From Messrs. George Glover and Co., with estimate for two Standard Dry Test Meters; dated 25 July 1870 142
9. From Messrs. G. Glover and Co., stating advantages of Test Dry Gas Meters; dated 29 July 1870 - „
10. From Mr. Crosley, on the use of Standard Test Gas Meters, and relative advantages of Wet and Dry Meters; dated 18 August 1870 - - „
11. From Mr. Mills, Inspector of Gas Meters, Western District of the Metropolis dated 19 September 1870 - 143
12. From Messrs. Geo. Glover & Co., forwarding Specification of new Standard Dry Test Gas Meters, to pass 2·5 cubic feet and 0·5 cubic foot respectively, 12 Nov. 1870 - - - - - - 145
13. From Mr. Geo. Glover, on the advantages of his Patent Dry Test Meter, dated 22 Dec. 1870 - - 146
14. From Mr. Hartley on the best method of using a Standard Test Gas Meter, and adjustment of water line; dated 22 Dec. 1870 - - - - „

1. *Introductory Remarks by the Warden of the Standards.*

The question of the construction and legalisation of a Standard Test Meter has been raised by the Metropolitan Board of Works and one of the Inspectors of Gas Meters in the Metropolitan District. The subject is one which may deserve the attention of the Standards Commission.

The construction and legalisation of Standard Test Meters, as supplemental to the Gas Measuring Standards established by the Sale of Gas Act of 1859, appear to me to be absolutely indispensable for more effectually carrying out the objects of that Act, in all those cases in which the Gas Measuring Standards cannot be used. I consider, therefore, that it is now expedient that two Standard Test Gas Meters, measuring respectively five cubic feet, and one cubic foot, at one revolution or complete action of the meter, should be constructed and legalised.

I have been informed by a competent authority that in the city of London, where copies of the Gas Measuring Standards are provided for the use of the Inspector of Gas Meters, it is the usual practice to test all fixed gas meters by a 20-light test meter, and to stamp them as duly verified.

It may also be observed that in the official Regulations for carrying out the new Weights and Measures Law in the North German Confederation,* the exceptional use of a Standard Test Gas Meter, in those cases in which a Cubic Measuring Standard cannot be employed, has been authorised.

The opinions of persons whose practical experience entitles them to attention, is expressed in the following papers upon the relative advantages and disadvantages of a wet or a dry meter as a Standard Test Gas Meter. The Commission will probably concur with me in opinion that a properly constructed wet meter is preferable, as it has a definite and invariable measuring chamber, which the dry meter has not. But it may deserve the consideration of the Commission whether two Dry Test Meters should not also be furnished to the Standards Department, with a view to comparing from time to time the accuracy of their measurement with that of the Wet Test Meters. An estimate for such Dry Test Meters has been given by Messrs. George Glover and Co.

As to the statutable authority for legalising a Test Meter as a Standard, this is clearly comprehended in sect. 6 of the Standards Act, 1866. The legality of the use of copies of such a Standard Test Gas Meter, as a Gas Measuring Standard by local Inspectors of Gas Meters, is to be considered with reference to sect. 3 of the Sale of Gas Act, 1859, which authorises the Gas Measuring Standards to be "gas holders measuring the cubic foot and such "multiples and decimal parts as the Treasury (now the "Board of Trade) shall judge expedient." There appears to me to be no doubt that Standard Test Gas Meters, which measure five cubic feet, and one cubic foot respectively at one revolution, come within this provision.

I am, &c.
H. W. Chisholm,
Warden of the Standards.

Standards Department,
26 July 1870.

2. *Mr. Cresy (of the Metropolitan Board of Works), to the Warden of the Standards.*

Metropolitan Board of Works, Spring Gardens,
15th July 1870.

My dear Sir,

Mr. Airey tells me that your Commission will sit to-morrow and that they would be disposed to entertain an application for the consideration of the advisability of authorising the use of a Standard meter for testing purposes, I doubt whether the Sale of Gas Act would permit of this, still it is very desirable your Commission should consider it, and I have therefore transmitted Mr. Airey's letter that you might be able to bring the subject before them.

Yours, &c.
E. Cresy.

H. W. Chisholm, Esq.

3. *From Mr. Airey, Inspector of Gas Meters in the Metropolitan District.*

Metropolitan Board of Works,
Meter Inspector's Office,
White Lion Street, Shoreditch, N.E.,
15th July 1870.

Sir,

I am frequently called upon to test large meters that are fixed upon the gas consumers' premises, and these meters are in all cases not readily removeable, being generally built in, in cellars, vaults, &c.

Hitherto the operation of testing has been performed by me by conveying to the premises of the consumer one of the verified standard gas holders, which from their bulk, weight, and height of the room required for the holder to stand in, is a frequent cause of serious inconvenience, which coupled with the risk of damage to the gas holder in its present form, renders it highly desirable that some other mode of testing gas meters in "situ" should be sanctioned by the Standards Commission, because even with the standard holder large meters cannot be tested in strict accordance with the present Sales of Gas Act.

I beg therefore respectfully to make application that the Standards Commission will be pleased to sanction the use of a standard test meter of not less capacity than five cubic feet at each revolution. The said test meter only to be used for testing gas meters fixed upon consumers' premises, and the following advantages will be gained:—

1st. Extreme portability.
2nd. Less risk of damage.
3rd. Greater facility in performing a test in any and every situation and in places where standard holder could not be fixed, with I believe equal accuracy in result.

Should the sanction of the Standards Commission be given I shall be prepared to submit drawings of a test meter for their approval. But in the event of their refusal I have to ask their sanction to a gas holder specially designed by me for outdoor purposes, and of which I have deposited a drawing and also working model of the alteration requiring their sanction.

I remain, &c.
Henry Airey,
Inspector.

H. W. Chisholm, Esq.

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* See App. XI. to 4th Report, p. 367.

Appendix VIII.—*continued.*

4. *Further Letter from Mr. Airey.*

Meter Inspector's Office,
White Lion Street, Shoreditch,
Sir, 26th July 1870.

In reply to your inquiry whether a dry gas meter would not be more available as a standard test meter than a wet meter, and equally as accurate, I beg to make the following observations and to state the reasons that have caused me to arrive at the positive conclusion that *a dry gas meter is not a fit and proper instrument to be used as a standard of measurement* for the purposes and use of Inspectors appointed to carry out the provisions of the Sales of Gas Act.

My capability of speaking positively may be gathered from the fact that I have been engaged for nearly ten years in testing gas meters, and that during the time more than 100,000 meters of all descriptions have passed under my supervision, two-thirds of the number being dry meters.

The disinterestedness of my observations may be assumed when I state that I am not connected in any way either directly or indirectly with the commercial prosperity of any meter, and therefore in speaking of wet and dry gas meters I only speak of them as to their capabilities of being made unalterable standard instruments of measure; apart from this both instruments can be made commercially correct.

And now, Sir, before proceeding to state my objections to a dry meter being used as a standard measuring instrument I would state what I conceive to be the qualifications necessary for a standard test meter to be employed and used only for testing gas meters of the same or of a greater capacity, and fixed upon the gas consumer's premises, or where a verified standard gas holder cannot be made available.

Qualifications.

1st. That its form, size, and strength of outer case should allow of its being carried from place to place very readily, easily passed through any ordinary doorway, so as to be placed by the side of the meter to be tested, and not readily liable to damage.

2nd. That it should possess levelling screws and levels affixed to the meter so as to ensure a perfect level while in use.

3rd. It should have a large circular dial upon which 5 cubic feet are marked, and each foot divided into tenths and hundredths; also there should be auxiliary dials registering 10 cubic feet, 100 cubic feet, and 1,000 cubic feet. The auxiliary dial should be removable, so that before commencing a test, the whole of the index pointers should stand at zero; or the pointers should be loose, so that the same result may be obtained, and then fixable by a set screw.

4th. That its measuring chambers should be made of such a material inflexible in its nature that after the meter has received the stamp as a standard of measure they will be unalterable from any circumstances apart from culpable negligence of the regulations for use to be issued by the Board of Trade.

5th. That should any valves be used for the purpose of conveying gas to and from the measuring chambers, they should not be liable to be in any way displaced while conveying the meter to and from its destination.

6th. That a standard test meter should be capable of being used immediately after notice of requisition, even though it has not been in use for six or nine months previously.

Lastly. It should be furnished with all appliances necessary for the inspector's use in the shape of cocks, thermometers, connections, &c.

Having thus stated the qualifications I believe from experience to be necessary, I now beg to state my objections to a dry standard gas meter, and will do so somewhat in the order of the qualifications named.

The first, second, third, and last can be equally possessed by both wet and dry meters.

4th. The measuring chambers of a dry meter are made of leather saturated with oil, and however carefully the leather may be selected and prepared, and however skilfully attached to its discs and rings, thereby ensuring perfect accuracy when first made, yet from the nature of the material used, and the form it takes in use, it will be seen upon consideration that they cannot always be relied upon to deliver the same amount at every action, or every occasion, at all times, and for length of time, with that strict uniformity and absolute certainty so necessary in a standard test meter, an instrument the correctness of which every inspector who has to use the same should be able to swear to if required.

5th. A dry meter for the measurement of gas requires two or more slide valves, according to the number of measuring chambers, and these valves for a standard meter would require to be very beautifully adjusted and fitted, thereby rendering them all the more liable to derangement in transmission from place to place. There is also a possibility of condensation taking place on the face of the valves, and though these objections could be partly obviated by allowing access to the valve chamber, I consider that no standard meter, after being stamped by the Warden of the Standards, should require cleaning or adjusting in parts, which in unskilful hands would be a constant source of error.

6th. I am very doubtful whether, according to the present construction of dry gas meters, a standard could be made which could be relied upon as a test meter *after being laid by say for six months;* which would frequently be the case, and then called into requisition at a day's notice. It would require to have a quantity of gas passed through it, and that it should be reverified by a standard gas holder every time it is required to be used under such circumstances; and even then, after transmission for that purpose, from the possibility of either the derangement of the valves or stiffness of the leathers of the measuring chambers, doubts would arise which would destroy all confidence in the accuracy of the test performed.

In the course of my official duties, I have had several dry meters brought here that have been tested and stamped but which have never been fixed or used, and yet upon re-verification after having laid by for some time, they have required re-adjusting, and it is a principle upon which all dry meter manufacturers act, themselves to retest all meters that have been in stock for a month or so prior to their being delivered.

If this occurs with meters that are allowed a range of error of 5 per cent., viz., from 2 per cent. fast to 3 per cent. slow, it proves that however commercially correct within the limits of the Sales of Gas Act dry gas meters are made, they are not at present fit to be considered unalterable standards of measurement, where the errors should not exceed $\frac{1}{4}$ per cent. either way, and which should in my opinion be the case with any test meter delivered to an inspector for his use.

These facts are tacitly admitted by almost every meter manufacturer, for the test meter they themselves use is a wet meter, having a capacity of 1 cubic foot at every revolution of the wheel, or one with a capacity of 5 cubic feet at every revolution.

Having stated the qualifications I consider necessary for a standard test meter, and my objections to the adoption of a dry meter, I would say that *the only meter fit from its construction to be used as a standard of measurement is a wet meter;* and this will be evident when it is considered that the measuring chambers are made of metal and therefore of an inflexible material, the actual capacity being fixed by a defined and unalterable water line, the quantity passed through the meter during every revolution of the wheel containing the measuring chambers, being accurately registered to the 100th part of a cubic foot by a long index hand fixed on the spindle of the wheel.

Another advantage is that no valves are required to convey the gas to the measuring chambers, and therefore there is nothing to get out of order during transmission from place to place; also that as the accuracy of the measurement is dependent solely upon the fixed water line, and being used on a level table or base, it follows that if the meter has been made suitable for the purpose, it matters not whether it has been laid by for one or six months, for upon charging the meter with water to the stamped water line, temperatures being equal, and the conditions for testing duly observed, it will always register the same.

In speaking thus of a standard wet test meter, I would state that I do not advocate it to supersede the verified standard gas holders, but only to be used in places and under conditions for which a standard gas holder is not readily available; that is to say, for testing gas meters fixed upon the consumer's premises, because wherever the test meter is used it will be necessary to have an apparatus, (for instance, one made somewhat in form like a circular bellows,) for the purpose of performing the pressure test, as prescribed by the sales of Gas Act. But should the provisions of this Act be rendered compulsory over the whole of the United Kingdom, the adoption of a standard test meter would surmount the objections at present raised to the adoption of the Act, viz., that the number of gas consumers in many towns, &c. is too small to warrant the incurring of the expenses in appointing an officer and providing an office for the legal verified standard; whereas with test meters, an officer might be appointed, who could unite in his district several of such towns, and could name days upon which he would attend. But wherever a town is of sufficient importance, I think it should be imperative that a verified standard holder should be used in an office properly fitted up for the purpose; the test meters and the pressure test apparatus being used only under the same conditions that they would be used in the Metropolitan district.

Should the use of a standard test meter be legalised in towns where no standard holder is available, it will be necessary that two or three sizes should be made to suit the requirements of different inspectors; because some might never be called upon to test a larger sized meter than a 20-light, whilst the greater number they would have to test would range from one to five lights. Other inspectors might be called upon to test meters up to 1,000 lights, hence the necessity that different sized test meters should be legalised, but they may all be made upon one and the same principle.

In concluding I must apologise for the great length of these remarks, but it has been my wish fully to explain my ideas upon the subjects of your inquiries.

I am, &c.
HENRY AIREY,
Gas Meter Inspector for the Northern and Eastern Districts of London.

H. W. Chisholm, Esq.,
Warden of the Standards.

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5. *Extract from " Gas Meter Testing under the Sale of Gas Act," by F. W. Hartley (London, 1869).*

THE TEST METER, AND THE MODE OF USING IT.

" In the present state of the law, test-meters cannot be employed by inspectors for meter testing, although such meters would be of the greatest utility for testing large meters which are fixed and in use at public buildings, factories, &c., and which cannot be removed to the inspector's office, except with great difficulty and expense. In the first edition of this treatise, the writer expressed a hope that an alteration of the law would be made, in order to permit the employment of test-meters; but such change, unfortunately as he thinks, has not yet taken place.

" A test-meter of the best construction is marked by the following peculiarities:—

" Its index is furnished with a large dial, indicating quantities at least as low as $\frac{1}{100}$ths of a cubic foot, and up to 100 or more cubic feet. One of the hands or pointers to this dial is fitted in such a way that it can be shifted backwards, and thus set at the zero point, without the necessity of working the meter or of stopping the passage of gas through it if the meter be in action. The water-line is at the point of accurate measurement, and is defined either by plug-holes, or by water-level gauges similar to those used on station meters.

" The special advantages possessed by a test-meter are its moderate dimensions, and the consequent facility with which it can be transported to, and deposited for use in, places where a gasholder is inadmissible; the ease with which it may be used; and the greater accuracy in the results over those obtainable by the employment of a gasholder under necessarily exceptional conditions. With the latter it is impossible to maintain a continuous discharge of gas or of air through a large meter.

" It is to be distinctly understood, that a test-meter can never be accepted and employed as an efficient substitute for the gasholder in the offices of meter inspectors, of meter makers, or of gas companies, inasmuch as the discharge of gas through it must be restricted to a uniform, or to a very nearly uniform, rate on all occasions, in order to secure correct measurement. It is, moreover, incapable of adjustments which would cause it to deliver gas at different and specific pressures; for although it would be easy to provide means for such adjustments, by the application of a water-wheel, of clockwork, or of a pulley and weight, in connection with the shaft of the measuring wheel, such application is certainly objectionable. Hence, with a test-meter, it is not possible to test another meter under any specified conditions as to pressure of gas; but this fact affords no basis upon which objections can be raised to the employment of test-meters for the purpose advocated.

" In order to demonstrate the accuracy with which a meter may be tested by another of smaller size, the following experiments were made:—

" A small wet meter was most carefully tested by discharging through it, at the exact rate due to its capacity, the entire quantity of air which a gasholder contained within the limits defined by its scale. *The meter was found to agree exactly in measurement with the gasholder.*

" The meter was then connected to a meter of ten times greater measuring capacity and of precisely the same construction as a station-meter, but without an overflow water-gauge. The water-line being defined by a socket opening and the water-level being adjusted when the meter was out of action.

" Gas was then passed through both meters in a continuous flow, at the precise rate at which the smaller meter had been tested, until the measuring-wheel of the larger meter has made several revolutions, as indicated by the index. *The registration of the meters was found to be in perfect agreement.*

" The larger meter was then tested at the rate due to the small meter, and with the same holder which had been used to test the small meter, and *was found to agree exactly in measurement.*

" The larger meter was then tested with the same holder at higher rates of working, and it slightly and regularly altered in its registration, until on being worked at its proper speed, and when therefore delivering its proper quantity of gas, the change amounted to the *insignificant* error of *one per cent. slow.*

" The greatest possible care was taken in these experiments, which were many times consecutively repeated, to preserve equality of temperature in the water in the gasholder and meters and in the air employed.

" With such facts as the above before his eyes—facts which the writer has repeatedly verified—with a knowledge of the manner in which inspectors use, and are *obliged* to use, gasholders for testing large meters which are *away* from the testing offices, and with the experience of years in the use of the test-meter, the writer is forced to entertain a firm conviction that accuracy is only to be attained, on most occasions, by the use of a test-meter for out-of-office work, and feels justified in advocating in the strongest terms the employment of a test-meter for such work, and for the purpose of determining the accuracy of large meters generally.

" As shown in the experiment on the larger meter above mentioned, a wet meter becomes *slow* to a certain limited degree when worked *above* the speed at which its measuring capacity has been determined.

" The reverse of this takes place when a meter is worked *below* its speed, and it becomes *fast* to a trifling extent.

" A test meter should not, therefore, when considerable accuracy is desired, be used in testing a smaller meter; for if it be so used, either the test meter must be worked *below*, or the smaller meter *above* its speed—in the first case the test meter would be *fast*, and in the latter the small meter would be *slow* in measurement.

" It is therefore evident that the best way to ensure the greatest attainable accuracy, is always to work the test-meter at its proper speed, thereby securing its proper measurement, and to use it only for testing meters of the same or larger sizes. The closer the relation in capacity between the test-meter and the other, the more accurate will be the results. If, therefore, test-meters were employed by public inspectors, it would be well to limit their application to meters not exceeding about 10 or 15 times the capacity of the test-meter. A 20- and a 100-light test-meter would then meet all probable requirements—the latter would be sufficiently large to test a meter of a size equal to the measurement of gas for 1,500 lights. If the large meter measured, when tested at one-tenth or one-fifteenth of its speed, to the extend of 1½ per cent. fast, it would be absolutely correct, or within ½ per cent. of correct measurement, when working at full speed.

" Test-meters are often used in small gas-works instead of a gasholder for testing meters, and when used with care, give results which, if not quite accurate, are near enough for the purpose intended—namely, the discovery of any considerable error in a meter's measurement.

" Supposing that it is a large meter, of the kind described as a station-meter, which is to be tested in an open yard or shed; the first thing which must be done is to adjust the large meter to a perfectly level and upright position by the aid of wedges, blocks, or any convenient means. Next, charge the meter with water as nearly as possible of the same temperature as the surrounding atmosphere, to the height of the marked water-line. Close up the inlet of the meter, in a perfectly sound manner, with the exception of a 1-inch or 1½-inch opening, which should be furnished with a short piece of iron or other suitable pipe. Close the outlet in a similar way, and attach a good thermometer, so that its bulb is within, or just in front of the opening.

" Place the test-meter on a perfectly levelled board or stand, as near to the large meter as possible. Charge the test-meter to its exact water-line with water of the same temperature as that used in the large meter.

" Upon the outlet of the test-meter screw a 1-inch or 1½-inch iron pipe, fitted with two 1-inch or 1½-inch main cocks, one above the other. The pipe should continue above the cocks to a height of 6 to 12 inches, and then terminate in an elbow from which should project horizontally, another pipe 8 to 12 inches in length. The elbow at the point above the vertical pipe should be fitted with a socket, through which the bulb of a thermometer, corresponding with that used on the outlet of the large meter, should be inserted and descend into the upright pipe. The socket must be closed by a ground-plug attached to the thermometer and through which the bulb projects.

Appendix VIII.—*continued.*

"Connect the *outlet* pipe of the test-meter with the *inlet* pipe of the large meter by means of a sound flexible tube, of the requisite size, taking care to bind the ends of the flexible tube with string to the metal pipes. Connect a gas supply pipe to the inlet of the test-meter.

"Pass gas through both meters until the air is expelled from them. During this operation the passage of gas may be adjusted to the proper rate for the test-meter by means of the lower cock on the outlet. When such adjustment is effected, remove the spanner of the lower cock without shifting the position of the plug.

"Now perfectly stop the outlet of the large meter, which can be most easily done if the 1-inch or 1½-inch pipe be furnished with a cock.

"If the test-meter index remain stationary during a few minutes, the connections and the large meter may be considered sound, but if any movement takes place, *leaks* must be sought for in the connections and about the meter case, by the aid of the *sense of smell alone;* unless the leak be *very trifling and the meter has had gas passing through it for a long time,* sufficiently long indeed to cause the measuring wheel to make at least 10 to 20 revolutions, for the application of a flame might lead to an *explosion,* which would be of *so serious* a nature with a large meter, that the slightest risk of it should be scrupulously avoided. Of course no danger of an explosion will ensue from the application of a light to a small hole in a meter which has had gas, and gas only, passing through it for a long time, *if the supply of gas be in excess of the discharge.* In testing, however, danger *may* be created if the test-meter be not perfectly *freed from air* before it is connected to the larger one.

"Having secured soundness in the connections and meters, open the pipe on the outlet of the large meter and let the gas flow through until the index hands of the large meter reach convenient positions to start from. Turn off the gas from the large meter by means of the upper cock on the outlet of the test-meter, and then turn back the hands of the test-meter to zero. Again turn on the cock of the test-meter and allow the gas to flow until the index hands of the large meter indicate that *two* or *more* complete revolutions of its measuring-wheel have been made. The instant this is shown, turn off the cock on the test-meter, and find the per-centage of error from the difference in the indications of the meters and of the thermometers, in the same way as when the gasholder is employed.

"Should the large meter be found incorrect, alter the water-line and retest as many times as may be needful.

"If the large meter be tested in a close room, a pipe must be extended from its outlet to a convenient and safe point of discharge.

"If the large meter be fixed and in use, it may be tested as it stands, but the direct passage of gas into it from the main must be cut off by means of a valve, or, if there be no valve, the inlet pipe may have a 1-inch or 2-inch hole drilled in it, and the passage of gas stopped by the insertion of a bladder or gas bag, well blown out to fit the inside of the pipe; but great care must be exercised in making the stoppage effectual, for sometimes there is much difficulty in doing this with a bladder or gas-bag. Having effected a complete stoppage in the pipe, drill holes below and above the valve or the gas-bag, and fit these holes with short pieces of pipe. The lower pipe is to supply gas to the test-meter, and the upper pipe for its passage from the test into the large meter. A pipe should also be attached to the outlet of the large meter, to convey the gas to a safe point of discharge, for it is not prudent to attempt to use the burners which may be supplied through the meter, inasmuch as the gas, in the testing process, will be turned on and off several times, and it will be scarcely possible to time the lighting of many burners, probably scattered, so as to avoid the escape of unconsumed gas."

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6. *Mr. Hartley to the Warden of the Standards.*

55 and 55A, Millbank Street Westminster,
16 July 1870.

SIR,

IN compliance with your wish I beg to hand you a few notes relative to Test Gasholders *v.* Test Meters for verifying large meters which cannot be removed from the consumers' premises to the Meter Inspector's office.

Shortness of time has prevented me writing fully on the subject, but what I have stated may possibly be of some assistance to you.

I also accompany this with an approximate estimate for such a test-meter as would, in my opinion, be suited for a model for the Standards Department.

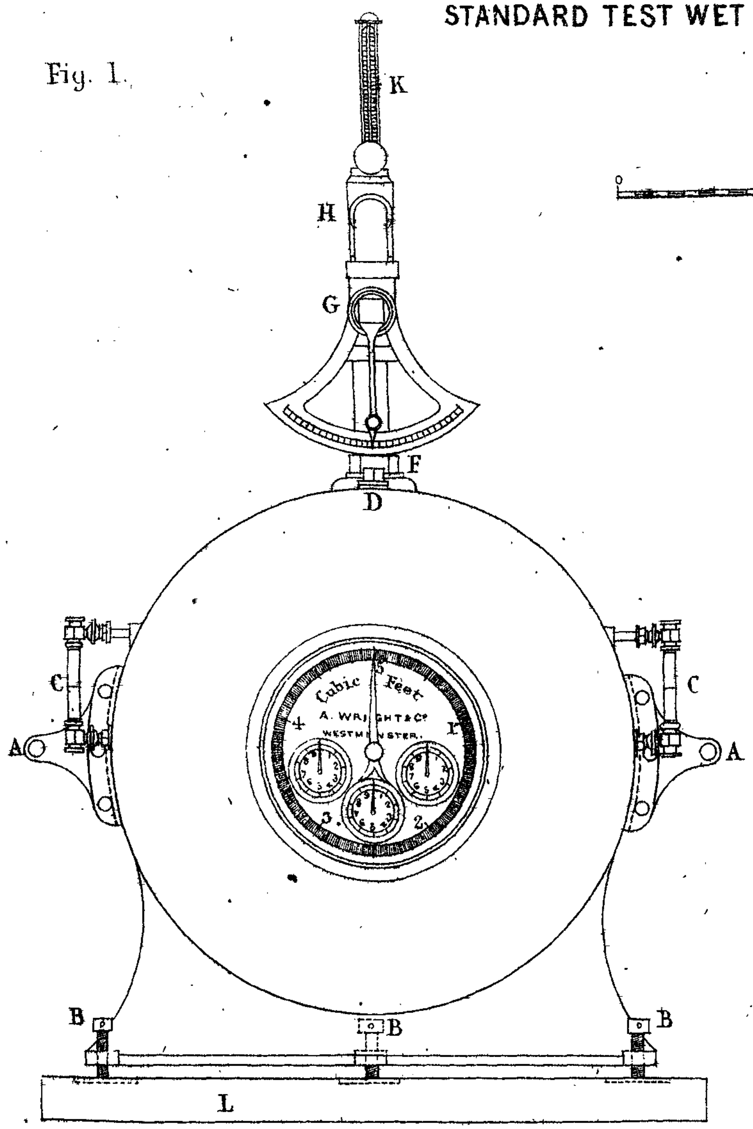
I am, &c.
F. W. HARTLEY.

H. W. Chisholm, Esq.
Warden of the Standards.

Test Gasholder.	*Test Meter.*
1. The weight of an ordinary test-gasholder is, with fittings, about 3 cwt. The weight of a portable gasholder, such as has been lately constructed, is about 6 or 7 cwt.	1. The weight of a test-meter, capable of passing five cubic feet per revolution (called a 100-light meter), is, as ordinarily made, with all the fittings shown in the accompanying drawing, except the base board, under 2 cwt.
2. The portable gasholder must, even for local use, have a special vehicle to convey it from place to place.	2. The test-meter can be packed in a case ready for transit by railway in a few minutes and unpacked as quickly. The meter can also be conveyed in a truck or cart, or, if the distance be short, even carried by a couple of men.
3. The gasholder requires a height of, at least, nine feet to stand in, and cannot be passed through any ordinary doorway. It must, therefore, frequently be placed at a distance from the meter which is to be tested, thereby causing increased danger of error from leakage owing to the length of pipe to be traversed by the gas.	3. The test-meter can be passed through most doorways, and can be set up for use with all its fittings in any place high enough for a man to stand in.
4. The gasholder is too heavy to be moved bodily from its carriage to the site on which it is to be used. It must frequently be partly taken to pieces and refitted, and requires adjustment on every occasion of using.	4. The meter will scarcely ever require any of its fittings removed, but may be generally carried to, and be placed on the site where it is to be used, entire.
5. With meters, the capacity of whose wheels exceeds 10 cubic feet, the test with one gasholder must be intermittent.	5. With a meter the test is continuous for as long a time as may be desired.
6. With a gasholder the expense and labour attending preparation and the actual testing are very considerable, and much time is demanded from the Inspector.	6. With a test-meter the trouble is reduced to a minimum and the test can be continued for a considerable time without demanding a continual supervision on the part of the Inspector. He might lock up the test-meter in a cellar with the meter to be tested, and leave the gas passing for an hour or two, if needful.
7. The test with a gasholder is unreliable, owing to the difficulties attending this mode of testing.	7. The test with a meter is trustworthy, and attended with no trouble or difficulties liable to falsify the results.
8. A portable gasholder, 11 cubic feet capacity, cannot be supplied, to return cost to the manufacturer, under 85*l.*, and this is exclusive of carriage for its support, and many fittings and appliances, which altogether would cost at least 50*l.* to 60*l.* more.	8. The cost of a test-meter, 100-light size, with case constructed of stout tinned charcoal iron, measuring wheel of stout metal of the same character as that of which the Standard Gasholders are constructed, hard enamelled dial, cocks, graduated arc, thermometer, levelling board, &c., as shewn in drawing, would be from 40*l.* to 50*l.* A cheaper test-meter, with wheel of tinned sheet iron, and similar to the 100-light meter sent for examination, would cost 28*l.*, without levelling board.

STANDARD TEST WET GAS METER MADE BY MESSRS WRIGHT & Co

Fig. 1.


K
H
G
F
D
Cubic Feet
A. WRIGHT & Co
WESTMINSTER.
1
2
3
4
5
C
C
A
A
B
B
B
L

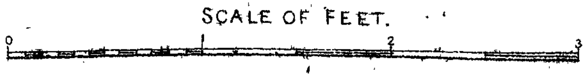

SCALE OF FEET.
0
1
2
3

Fig. 2.

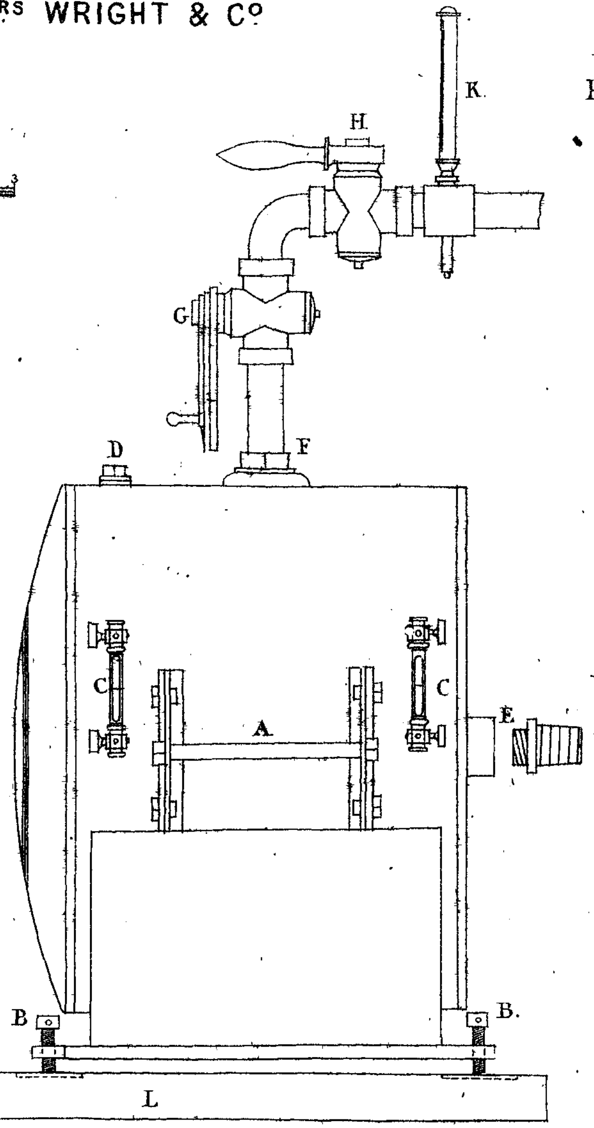

K.
H.
G
D
F
C
C
A.
E.
B
B.
L

Plate 5.

Appendix VIII.—*continued.*

Short Specification of a Model Test Meter for the Standards Department of the Board of Trade.

The meter to be of the size known as 100-light, that is, the measuring wheel to be of such a capacity as to deliver 5 cubic feet of gas or air per revolution.

The measuring wheel, the interior of the case, the water-level gauges, and all parts exposed to the action of the gas or water, with the exception of the shaft, outlet pipe, and cocks, to be composed of metal of the same description as that of which the bells of the standard gasholders are constructed.

The shaft of the measuring wheel to be made of the best bell metal.

The meter to be provided with an index having an engraved or hard enamelled dial capable of indicating from the 100th of a cubic foot to 1,000 cubic feet.

The external case of the meter to be made of charcoal-tinned iron, No. 18 B.W. gauge of the very best quality, and to be finished in japan. To the base of this case a stout wrought-iron frame is to be affixed, such frame to be furnished at three points with long steel screws by the aid of which the meter may be levelled.

Two water-level gauges to be affixed to the front and one to the back of the meter; each of the gauges to have a line marked upon it to indicate the height at which the meter must be charged with water in order to ensure true measurement of gas or air.

A stout levelling board to be provided fitted with three metal socket plates in such a position as to receive the three points of the levelling screws when the meter is placed over the board.

The meter to be provided with a 2-inch brass union on both its inlet and outlet, and also upon its outlet with 2-inch iron pipe and fittings consisting of two 2-inch brass cocks, graduated arc, spanners, thermometer, &c. as shown in drawing.

We would undertake to manufacture and supply a test meter most carefully constructed in all its parts and of the very best materials, in complete accordance with the spirit and signification of the foregoing short specification for the sum of 65*l.* or near to that sum.

For Alexr. Wright & Co.
F. W. Hartley.

55 & 55a, Millbank Street, S.W.,
16th July 1870.

Test-meter constructed to pass five cubic feet at one revolution, with dial indicating quantities of gas from the 100th of a cubic foot to 1,000 cubic feet. (*See Figs.* 1 & 2.)

A, handles for lifting the meter—removeable.
B, adjusting screws for levelling.
C, water level gauges.
D, socket through which the meter is charged with water.
E, inlet for gas.
F, outlet for gas.
G, cock with lever on plug, and with graduated arc for adjusting the rate of flow of the gas.
H, stopcock.
K, thermometer for indicating the temperature of the issuing gas, fitted into a horizontal cast-iron box, so that if the bulb of the thermometer be broken no mercury can enter the meter. The spilled mercury to be drawn from the box through the screwed hole.
L, base board with socket plates to receive the ends of the levelling screws B.

7. *Further from Mr. Hartley.*

55 & 55a, Millbank Street, Westminster,
22nd July 1870.

Sir,

In reply to your further inquiries respecting test-meters, I beg to say that I am still of the opinion expressed in my little pamphlet on "Gas Meter Testing," viz., that the official Inspector of Gas Meters should be allowed to use test-meters of two sizes, the one of such capacity as to deliver 5 cubic feet of gas per revolution, and the other to deliver one cubic foot per revolution for the following reasons:—

1st. In the country the area of an inspector's district will sometimes, perhaps generally, be much greater than in London, and indeed there are at the present time inspectors whose districts include the whole counties in which they are appointed. It is quite possible that in some districts there may be very few, if any, meters in use above 100-light size, and, owing to the distance at which they are situated from the inspector's gasholder testing station, the expense of carriage to and fro may be considerable, the expenses of taking down and packing, and the inconvenience which the consumer may be put to by the absence of his meter for several days must also be taken into account. Whilst it is desirable that for very large meters a 5-cubic foot test-meter should be used, meters of 20-light size to considerably above 100-light size can be perfectly re-verified by a 1-cubic foot test-meter, with much less inconvenience and cost, by the attendance of the inspector periodically, or at such times as he might find necessary, at the various parts of his district.

2nd. Even in London it may be at times advisable or desirable to reverify "in situ" meters of smaller size than 100-light, in order to determine the registration under the conditions in which they are actually at work, for the purpose of determining disputes between the buyer and the seller of gas.

In my opinion the inspectors should be empowered to make such reverification upon a requisition signed by the consumer of gas or by the gas company, or by both parties, being delivered to him. The 5-cubic foot test-meter would be too cumbrous for such purposes generally, and would frequently be inapplicable.

In answer to your question, "Why should the test-meter "be necessarily of the wet kind?" I give the reasons which follow, and it is to be understood distinctly that these reasons apply to meters constructed in the best possible manner, and which meters are in proper working conditions.

Dry Meter; reasons against.

Because in the dry meter the measuring chambers are composed partly of flexible material, and the measurement is, moreover, dependent on the preservation, under all conditions of use, of the absolute soundness of the slide valves, by which the gas or air enters into and is discharged from the measuring chambers.

Because the dry meter is subject to disturbing influences which alter its measuring capacity, and the existence of such disturbing influences could not be known at the time of using the meter or even before or afterwards. The meter might under conditions as nearly identical as it would be possible for the inspector to command, vary to the extent of 2 or 3 per cent. and the inspector know nothing of such variation.

Because no means can be devised with a dry meter which will enable it to afford internal evidence of its accuracy as to measurement, and it would therefore be needful to reverify at frequent intervals to avoid as much as possible the chance of error.

Wet Meter; reasons for.

Because the measuring wheel of a wet meter, divided so as to form four chambers, each sealed or bounded by water on one side, is composed of what may be practically accepted as inflexible material, incapable of any variation in capacity, except only by the elevation or depression of the water-level, and the measurement is independent of the action of any valves whatever.

Because the wet meter is free from any influences capable of disturbing the measurement when used under definite conditions which the inspector can realise and command with sufficient exactness.

Because the measuring wheel being composed of inflexible material, and the depth of its immersion in water, necessary to cause it to deliver an exact quantity per revolution being determined by careful experiment, and the depth of immersion being defined by distinct lines cut or marked upon proper gauges affixed to the case of the meter and in communication with the interior, it follows that on reimmersing the wheel to the original depth, by charging the case with water to the lines marked on the gauges, optical evidence is afforded of the meter being in condition to register correctly. Hence retesting at frequent intervals would be unnecessary.

In respect to transport the wet meter is, to say the least, as little liable to injury as the dry. The 100-light test meter which I sent for inspection last week to the Standards Department, has travelled about the country for 10 years or more, and has never sustained any damage which rendered its measurement inaccurate.

Appendix VIII.—*continued.*

The dimensions of a 20-light test meter are, diameter 20 inches, depth from front to back 18 inches, and height 24 inches. The price for one complete, fit for an inspector's use, with fittings on inlet and outlet and levelling board, would be about *15l.* or *16l.*

I am, &c.
H. W. Chisholm, Esq., F. W. Hartley.
Warden of the Standards.

Short Specification of a Model Test Meter for the Standards Department of the Board of Trade.

The meter to be of the size known as a 20-light, that is, the measuring wheel to be of such capacity as to deliver one cubic foot of gas or of air per revolution.

The measuring wheel, the interior of the case, the water level gauges, and all parts exposed to the action of the gas or water with the exception of the shaft, pipe fittings, and cocks, to be composed of metal of the same description as that of which the standard gasholders are constructed.

The shaft of the measuring wheel to be made of the best bell metal.

The meter to be provided with an index having an engraved or hard enamelled dial capable of indicating from the 1/100th of a cubic foot to 100 cubic feet.

The external case of the meter to consist of charcoal-tinned iron, No. 18 B.W. gauge, of the very best quality, and to be finished in japan. To the base of this external case a stout wrought-iron frame is to be affixed, such frame to be furnished at three points with long steel screws, by the aid of which the meter may be levelled.

Two water gauges to be affixed to the front part and one water gauge to the back part of the meter; each of these gauges to have a line marked on it to indicate the height at which the meter must be charged with water to ensure the measurement of gas or of air.

A stout levelling board to be provided fitted with metal socket plates in such position as to receive when the meter is placed over the board the three points of the levelling screws.

The meter to be provided with a 1¼″ union on both its inlet and outlet, and also upon its outlet with 1¼-inch iron pipe and fittings consisting of two 1¼″ brass cocks, graduated arc, spanners, thermometer, &c.

We would undertake to manufacture and supply a test-meter most carefully constructed in all its parts and of the very best materials in complete accordance with the spirit and signification of the foregoing short specification for the sum of *25l.*, or near to that sum.

For A. Wright & Co.,
F. W. Hartley.

55 & 55a, Millbank Street, S.W.,
22nd July 1870.

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8. *Messrs. George Glover & Co.*

Ranelagh Road, Pimlico, London, S.W.,
25th July 1870.

Sir,

In reply to your favour of the 23rd inst. we beg to express our opinion that far greater accuracy can be attained by the employment of our dry meter instead of wet ones for the purpose of testing other meters, *especially under varying pressures of gas.*

We shall be happy to make for your department a 20-light dry gas meter of the greatest accuracy for testing purposes, of the best tin plate, and of anti-corrosive metal, with plate glass top, on which is inscribed a dial to register by each complete action of the meter ½ cubic foot and its decimal parts for *6l. 6s.*

We shall also be happy to make for your department a 100-light dry meter of similar construction and of extreme accuracy, recording on the plate glass dial 2·5 cubic feet *for 20l.*

We are, &c.
H. Chaney, Esq., George Glover & Co.
Standards Department,
Board of Trade.

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9. *From Messrs. George Glover & Co., in continuation.*

Ranelagh Road, Pimlico, London, S.W.,
29th July 1870.

Sir;

In compliance with your request, I beg respectfully to submit the following remarks on the subject of testing gas meters by standard meters, "wet" and "dry."

Ingenious in principle, the wet meter has been found defective in practice. The bottom of the measuring chambers is defined by the plane of water in the meter, and the measuring chambers are diminished or enlarged by the accidental quantity of water that may be present at any given instant. The water is continually undergoing change of level from evaporation, which is more or less rapid according to the quantity of gas which passes through the meter, and the change of temperature. The wet meter likewise varies in its measurement with every departure from the true horizontal plane. Inclined forwards it measures "too slow." If backwards "too fast." It also varies with the varying pressure of the gas as it enters the meter. To render a wet meter a fixed measure, four things are essential:—

1. That the pressure of the gas as it enters the meter be uniform.
2. That the plane of the water remain fixed.
3. That the bottom of the meter be parallel with the plane of the water.
4. That the meter be placed and maintained on a horizontal plane.

Compliance with the first of these conditions is impracticable, and with the others exceeding difficult in practice. This renders the wet meter inapplicable as a test meter, where the pressure of the gas varies. The error in the measurement may amount to 4 or 5 per cent. Besides the internal measuring chambers of a wet meter become gradually coated with deposits from the gas and water, and their measuring capacity diminished, and I know of no method by which this can be prevented.

A properly made dry meter will not vary one per cent. under the different pressures used in gasworks, and different quantities of gas passing through it. And it has the great additional advantage that it cannot be tampered with without showing evidence of its having been so. A dry test meter is much more portable and convenient for being carried about.

Made of anti-corrosive metal, it is not subject to the corrosive power of the chemical constituents of coal gas and water. It is more durable than the wet meter, and the cost of it is much lower.

I shall be happy to have the opportunity of giving fuller information on the subject, at any time you may desire.

I have, &c.
H. W. Chisholm, Esq., Geo. Glover.
Warden of the Standards.

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10. *From Mr. W. Crosley.—On the use of Standard Test Gas Meters, and relative advantages of wet and dry meters.*

28, St. James' Square, Notting Hill, W.,
18th August 1870.

Sir,

Referring to the communications I have had with you on the subject of the desirability of legalising certain wet and dry gas meters to be used as primary or secondary standards in certain cases and under certain circumstances, and to your request that I would express to you my opinion thereon in writing, I have now much pleasure in doing so, as a person who has had much experience in the subject, and one who is completely disinterested on the matter, not having any connexion whatever, either directly or indirectly, with any meter manufacturer, and being free from any prejudice against either one kind of meter or another, except so far as my sincere convictions induce me to state my candid opinions of their real merits or demerits in either case.

I consider that all meters up to a size capable of passing 1,000 cubic feet per hour at half an inch pressure of water on the inlet, and used for measuring gas sold to consumers, should be tested by a gasholder, and that such mode of testing for such meters should be the only legal one. But there are many cases where it would be a great convenience to be able to make an approximate test of such meters, either large meters *in situ*, or other meters in small towns and villages where there is not the legal means of testing by gasholder. For such purposes, and in such cases, I not only know no substantial objection to, but should be glad to see provision made for the adoption of legally stamped wet meters, to be used by local inspectors for comparing such meters, as are used in the sale of gas, under the

Appendix VIII.—*continued.*

circumstances above stated. But they should only be used as supplemental standards, with the view of affording *primâ facie* evidence of accuracy, commercially, but not scientifically. Such evidence ought to satisfy both buyer and seller of gas that the meter used is sufficiently near truth to be considered commercially correct, and might obviate the necessity of incurring further trouble and expense in removing it, and sending it a considerable distance to be tested by the gasholder or more authoritative standard, if both parties to its use are satisfied. But in case either one or the other of such parties are not so satisfied, then the meter to be used for the sale of gas should be sent to the inspector to be tested by the gasholders as the only *absolute* test for meters passing up to 1,000 cubic feet of gas per hour.

For this purpose three wet test meters might be constructed and legalised, say, one to pass one cubic foot, another to pass five cubic feet, and the third 10 cubic feet respectively at one revolution of the measuring wheel.

No meter, whether for testing or for measurement of gas sold, should be allowed to travel at a greater speed than 100 revolutions of the measuring wheel per hour.

For all meters of sizes to pass upwards of 1,000 cubic feet per hour I would recommend the adoption of a legalised secondary standard test meter, and verified copies to be used as local standards. I consider these to be required on account of the great expense, trouble, and liability to accident of extending what I term the gasholder test to very large meters. In some cases, indeed, from the very large sizes requisite for the gasholders, the testing, according to the present Act, would be rendered impracticable. Besides, in very large meters there is not the same extent of objection to the use of a test meter, as a standard of comparison, as there is in small ones. But in no case, whatever may be the size of the test meter used, or the meter to be tested by it, would I recommend that a greater speed should be permitted than 100 revolutions of the measuring wheel, or chambers of the smallest meter used in testing or comparison.

I consider that the "*test meters*" should be all of the class known as "*wet*" and not "*dry*" meters, from the liability to derangement of the latter, and to their becoming inaccurate after they have been tested and stamped as correct, more particularly under certain circumstances to which they would be liable in practice, by either expansion or contraction of the leather of diaphragms, by high differential pressures between the inlet and outlet, by escape of gas at the valves from their not remaining perfectly gas-tight under all circumstances, from the leather diaphragms becoming leaky or porous, from the joints of the leather and metal becoming unsound, and from other causes not necessary now to enumerate.

As an example, I may mention that I was some time ago told by the manager of the gas works in a town where dry meters were used, and the staple trade is of a kind that is termed "season business," and where very little gas is used, except during the winter months, and consequently the meters remain for a considerable time out of action, that when required to be started again they would generally not move or work till an excessive pressure was put on the inlet of the meter with the outlet open, and even then the diaphragms burst in some cases before the valves and cranks, and other working parts, which had corroded or stuck fast, would move. If they would work at all under such circumstances, I am satisfied that the accuracy of their registration could not then be depended upon, even if correct when originally fixed.

I sincerely wish that the dry meter could be made so perfect that it could be relied upon at all times and under all circumstances, because the necessity for periodically supplying water to the wet meter, and in many cases at very short intervals of time, is certainly a very great objection to its use, especially in meters which do not compensate for the evaporation of the water.

The indices of all test meters should have a large dial in front, with an index pointer fixed on the spindle of the measuring wheel; the dial, index, and pointer all being so large that the divisions on the scale, representing the one hundredth of a cubic foot, could be read off with facility by the naked eye at a distance of, say, four feet, and with counting apparatus registering up to, say, 1,000 feet. The index should be so boxed up, and secured by the official seal guaranteeing its accuracy, that it could not be got at without destroying such seal.

I have, &c.

H. W. Chisholm, Esq. William Crosley, C.E.

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11. *From Mr. Mills, Inspector of Gas Meters in the Metropolitan District.—Remarks on Standard Test Gas Meters, as to their rates of speed and pressure, with Table of Experiments.*

Metropolitan Board of Works' Meter Inspector's Office,
St. Ann's Street, Westminster, S.W.,
19th September 1870.

Sir,

The question of using a "standard" test meter in lieu of a gasholder, for testing large meters on the consumers' premises, having been under discussion and recommended by experienced persons connected with that business, and being myself interested in the correctness of any instrument that may be used for such a purpose, I feel anxious lest an incorrect conclusion may be arrived at, based upon a wrong theory. I have, therefore, taken the liberty of making a few remarks upon the subject, corroborating my opinions by some simple facts, based upon a series of experiments carefully made by me with two test meters, a "wet" and "dry," manufactured by two of the most eminent firms in London, and intended to pass 120 cubic feet per hour.

A "standard" measure, as its name implies, should be a vessel containing the same quantity in bulk under all similar circumstances, more particularly when other measures are to be judged by it. Now, it is patent to all practical men, who have studied the subject in all its bearings and details, that such a result cannot be obtained from a gas meter, either "wet" or "dry." It is a well known fact that, although the measuring chambers of a wet meter are made of metal, and therefore inflexible, nevertheless, in the measurement of gas, those chambers are dependent for their actual correctness on the height of the surface of the water in which the measuring drum revolves. In a dry meter the attainment of the same object is entirely dependent on the flexibility of the leather composing part of its measuring capacity, and on the soundness of its movable parts.

To make myself clearly understood I will explain, first, the construction of the wet meter and its working, and, afterwards, the dry meter, with the objections to each of these instruments as a standard measure.

The wet meter is composed of an outer cylindrical case made of tinned sheet iron, in which is fitted a metal drum or wheel of given dimensions, working or revolving on its axis. This drum is divided by partitions into four angular compartments, the ends being partially enclosed by diagonal plates, each extending over rather more than one quarter of its surface, and overlapping each other, with openings reaching from within a short distance of its axis (thus leaving a distinct central space) to the outer rim. To one end is attached a convex cover with a centre opening. To prepare the meter for use, water is poured into it up to the level of an overflow pipe, and until the drum is immersed above the centre opening. A bent pipe is inserted between the cover and the enclosed end through which the gas passes into the measuring chambers. When each of these chambers become filled, the pressure, coming in contact with the water and acting on the surface of the drum, causes it to revolve, and discharges the gas through the openings in the opposite end into the outer case, and from thence to the burners. The loss of pressure between the inlet and outlet parts, caused by friction and draught, gives the motion.

Now, the exact quantity the drum may discharge at one revolution is dependent on the depth of immersion, or, in other words, on the water line in the meter. This is generally regulated, when working it, at a speed of 120 revolutions per hour, and a pressure of gas equal to a column of water 0·5 inch high.

When the meter is to be tested it is charged with water to the top of the overflow pipe. It is indispensable that it should stand on a surface perfectly horizontal, as much depends upon the level of its base; for should the meter be inclined backwards, it will unduly fill the measuring chambers with water, give less space for gas, and consequently register too fast; and if inclined forward, it will tend to partly empty those chambers and cause the meter to register slow from its horizontal line. If tilted forward to about 45 degrees, the centre opening will become unsealed and allow the gas to pass through unregistered.

When the meter is charged with water the inlet and outlet should be open to allow the water to find its proper level. The supply and discharge pipes are then connected. Immediately upon the gas being turned on, the pressure acting upon the surface of the water in the chamber which is being filled with gas, causes the water to be depressed, and thus forced into the outer case, where the pressure is less through the friction and draught. When the meter is worked at a slow or moderate speed, the friction being slight, the water will be nearly level throughout all its

Appendix VIII.—*continued.*

parts, and very fair results as to correctness of measurement may be obtained; but as the speed is increased so is the friction, and the water becoming more depressed in the filling chambers, gives more gas space, and thereby registers slow.

The following are the results of a number of experiments made with a 20-light "wet" test meter at pressures varying from 0·5 to 3·0 inches, and with quantities ranging from half to four times its proper measuring capacity per hour.

20-Light "Wet" Meter, Revolution 1·0 ft. Quantity per hour, 120 cubic feet.

Rate of Consumption per Hour in Cubic Feet.	Registration.		Pressure.		Temperature.	
	Meter.	Holder.	Inlet.	Outlet.	Gas, Outlet.	Registration of Holder, assuming the Meter to be correct at 120 ft. per hour, and pressure of 0·5 inch.
	Cubic Feet.	Cubic Feet.	Inch.	Inch.	Fahrenheit °	
60·30	10·00	10·10	0·50	0·44	64·7	9·98
120·60	10·00	10·12	0·50	0·42	64·7	10·00
180·00	10·00	10·14	0·50	0·30	65·5	10·02
246·00	10·00	10·22	0·50	0·19	65·7	10·10
300·60*	10·00	10·18	0·50	0·05	65·5	10·06
60·30	10·00	10·11	1·00	0·94	62·5	9·99
120·60	10·00	10·14	1·00	0·90	62·5	10·02
180·00	10·00	10·17	1·00	0·81	63·0	10·05
239·70	10·00	10·18	1·00	0·70	59·5	10·06
361·20	10·00	10·26	1·00	0·31	59·5	10·14
60·60	10·00	10·10	2·00	1·94	59·5	9·98
120·00	10·00	10·14	2·00	1·88	59·5	10·02
179·20	10·00	10·18	2·00	1·85	59·5	10·06
240·30	10·00	10·18	2·00	1·67	59·5	10·06
430·80	10·00	10·36	2·00	1·05	59·5	10·24
60·60	10·00	10·05	3·00	2·97	58·0	9·93
120·00	10·00	10·04	3·00	2·93	57·8	10·02
180·30	10·00	10·09	3·00	2·82	57·8	10·07
240·00	10·00	10·10	3·00	2·75	57·5	10·08
360·30	10·00	10·23	3·00	2·35	57·7	10·11
475·20	10·00	10·31	3·00	2·11	57·5	10·19

* Outlet of meter open.

It will be seen from the above table that the results show a difference between the registration of the meter and of the gas holder, or a liability to error of over two per cent.

I was unable to work the meter at a much greater speed without destroying its registration. At five times its proper measuring capacity and 2·0 inches pressure, the centre opening became unsealed, and allowed part of the gas to pass unregistered.

The construction of a "dry" test meter and its mode of measuring gas is as follows:—The outer case is of an oblong form, the gas enters through a pipe at the side into the valve box, thence into two circular chambers divided from each other by a plate of tinned iron. Each chamber is formed by a metal disc, with a band of leather by which it is attached to the middle metal plate, thus forming two measuring spaces which are allowed to expand and contract by means of the leather rims; the displacement caused by these discs working to and fro gives the measurement of the gas, the supply to and discharge from both sides of each chamber being regulated by sliding valves.

Now the first objection to the use of a "dry" meter as a standard is the uncertainty of the continued soundness of the valves, for, although the greatest amount of care may be taken in their fitting to render them sound, still, by reason of the extreme delicacy of their adjustment, and of the freedom from friction, which is necessarily required in their working, a particle of dust or any slight deposit from the gas getting between the seating and cover will cause them to become unsound. They will then pass a small quantity of gas unregistered.

Again, the correct measurement of the gas is dependent upon the distance the discs may travel to and fro, or to the equal bending of the leathers, and both will be determined to a great extent by the pliability of the leather. Should the meter be out of use for some time, or be exposed for any lengthened period to a heated atmosphere, these leathers are likely to become stiff. They will consequently not expand to their full extent, and will thus cause the meter to register fast. The leathers being a flexible material are also liable to be affected by the variation of pressures on the mains.

The following are the results of some experiments made with a dry meter, manufactured to pass 120 cubic feet per hour at a pressure of 0·5 of an inch, and, as nearly as may be, under the same circumstances as the previous experiments with a wet meter.

20-Light "Dry" Meter, 0·5 cubic foot per Revolution, 120 cubic feet per hour.

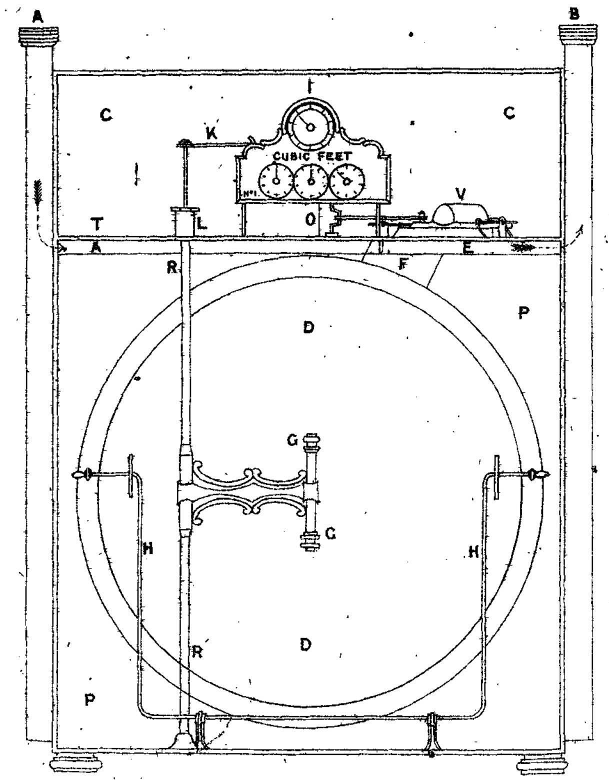
Rate of Consumption per Hour in Cubic Feet.	Registration.		Pressure.		Temperature.	
	Meter.	Holder.	Inlet.	Outlet.	Gas in Holder.	Registration of Holder, assuming the Meter to be correct at the rate of 120 ft. per hour, and pressure of 0·5 inch.
	Cubic Feet.	Cubic Feet.	Inch.	Inch.	Fahrenheit °	
60·00	10·00	10·10	0·50	0·43	61·0	10·07
120·60	10·00	10·03	0·50	0·37	61·0	10·00
180·30	10·00	10·06	0·50	0·26	61·2	10·03
243·00	10·00	10·05	0·50	0·12	61·2	10·02
294·00*	10·00	10·04	0·50	0·00	61·4	10·01
60·00	10·00	10·08	1·00	0·93	62·3	10·05
119·70	10·00	10·02	1·00	0·87	62·5	9·99
180·00	10·00	10·03	1·00	0·77	62·5	10·00
241·20	10·00	10·01	1·00	0·63	62·0	9·98
360·60	10·00	10·03	1·00	0·26	62·0	10·00
59·70	10·00	10·13	2·00	1·93	62·5	10·10
120·00	10·00	10·02	2·00	1·87	62·5	9·99
179·10	10·00	10·00	2·00	1·77	62·5	9·97
238·00	10·00	9·99	2·00	1·66	62·5	9·96
516·00	10·00	10·07	2·00	0·52	62·5	10·04
60·00	10·00	10·12	3·00	2·94	57·2	10·09
120·00	10·00	10·04	3·00	2·90	57·2	10·01
180·00	10·00	10·03	3·00	2·78	57·2	10·00
238·80	10·00	10·05	3·00	2·67	57·4	10·02
361·80	10·00	10·10	3·00	2·25	57·5	10·07
648·00	10·00	10·29	3·00	0·68	57·5	10·26

* Outlet of meter open.

To face p. 146

Plate 6.

INTERIOR OF MESSRS GEO GLOVER & COS 10 LIGHT DRY GAS METER.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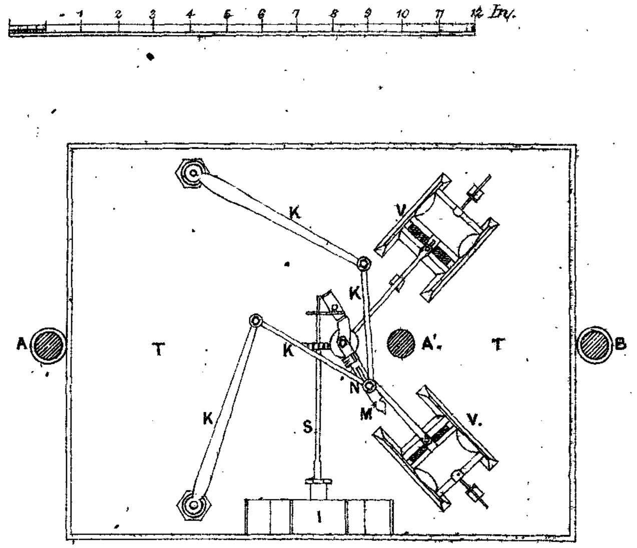
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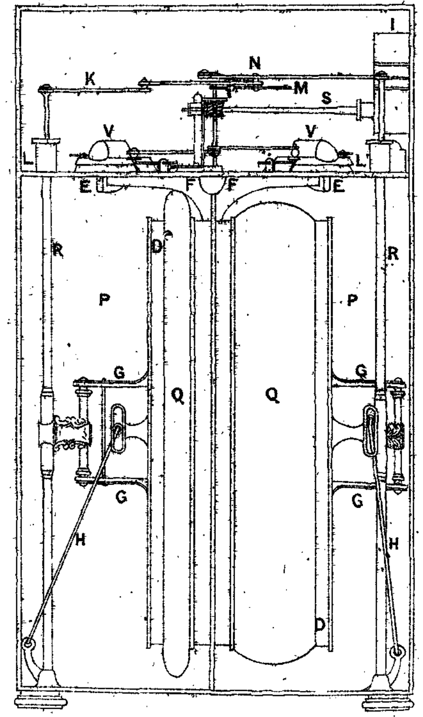
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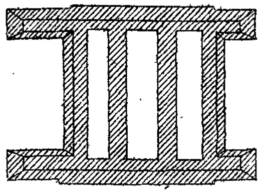
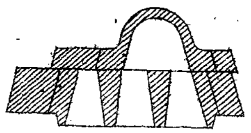
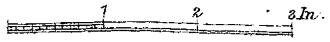
Plan of Grating



Section of Valve & Grating





Vincent Brooks Day & Son Lith

Appendix VIII.—*continued.*

Although I have here stated my objections to meters, both wet and dry, I do so entirely upon the ground of them being used as a "standard" measure, and not for one moment to infer that they are not reliable as a fair test of measurement of quantity between the seller and buyer of gas. I believe they are commercially perfect, that is to say, they can be made to register within two per cent. of the correct measurement under ordinary circumstances.

It must be borne in mind that the foregoing experiments were made under the most favourable conditions, having been conducted in my office, where I have every facility for regulating the temperatures of gas, air, and water. But in testing large meters, *in situ*, those favourable circumstances cannot be obtained.

It has been suggested to me that a table of corrections might be made as to speed when using a wet meter, but, unfortunately, the results would vary according to the resistance the test meter would meet with arising from the friction on the meter tested. For should the meter under test work with more than its ordinary amount of friction, it will again tend to alter the water line in the standard test meter, and consequently its registration, even supposing such a table, allowing for resisting friction, was adopted, it would be worse than useless in the hands of an inexperienced or *careless* person, as it might only tend to further mislead him. No doubt with a most skilful operator, and where great care is used, such a table might to a certain extent be useful. With a dry meter no corrections for speed or friction could be made, as they are so erratic in their working that different results are sometimes obtained without any apparent cause.

But should a standard test meter be ultimately adopted, I would suggest that the variation allowed on the meter to be tested should not exceed 0·5 of a cubic foot per cent. over and under from the correct measurement, this would partly tend to remedy or lessen the evil complained of, but would not overcome it.

In conclusion, allow me to state my opinion that the difficulties in using a portable "gasholder" are more imaginary than real. I have now been practically engaged 17 years in testing meters, and eight years prior to that in the general distribution of gas, during the whole of that period I have not yet had a meter to test where any little difficulty of position could not be overcome. And when gas companies become fully aware that meters will require occasional testing, *in situ*, they will take care that they are fixed in places easy of access.

I am, &c.
G. Mills,
Inspector of Meters
for the Western District
of the Metropolis.

To the Secretary,
Standards Commission.

Note by Mr. Chaney.

As illustrating the necessity of a Table of corrections for meters tested beyond the speed at which they are intended to be used, it may be interesting to state the following results, deduced from Mr. Mill's experiments with a 20-light wet meter, having a drum of 17 inches in diameter. The pressure is measured by the difference between the pressure gauges on the outlet and inlet pipes of the meter:

Rate per Hour.	For every 0·1 inch pressure lost in working the Meter, the registration appears to be
Cubic Feet.	
120	0·1 per cent. slow.
180	0·08 „
240	0·06 „
360	0·036 „
480	0·034 „

Here 120 cubic feet per hour is the rate at which the meter is intended to be used.

This Table shows that it will be impossible to test with accuracy a large meter by a small one, (for instance, a meter passing 500 ft. per hour by a test meter passing 100 ft. per hour,) without allowing for these variation of pressure.

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12. *From Messrs. Geo. Glover and Co. forwarding Specifications of new Standard Dry Test Gas Meters, to pass 2·5 cubic feet and 0·5 cubic foot respectively at one revolution or complete action of the Meter.*

Ranelagh Road Pimlico, London, S.W.
12th Nov. 1870.

Sir,

In accordance with the instructions contained in your favour of 5th Sept., we now beg to hand you short specifications for the two dry test gas meters we have made for your Department, accompanied with a drawing and statement explanatory of the construction of our meters.

We are, &c.
Geo. Glover & Co.

H. W. Chisholm, Esq.,
Warden of the Standards.

Specification of a 20-Light Dry Test Meter for the Standards Department of the Board of Trade.

The meter to deliver half a cubic foot at each revolution or complete action, and to be of the following dimensions:—

	ft.	in.
Height, to top of unions - - -	1	11½
Depth, from back to front - - -	1	0½
Width, from exterior rings of unions -	1	6⅝

The external case to be made of 20 B. W. gauge best charcoal tinned iron.

All the parts that come in contact with the gas to be made of anti-corrosive material, and of such suitable alloys as the different working parts require.

The "inlet" and "outlet" pipes to be 1¼ in.

The top of the meter to be made of strong plate glass, on which a circular dial, six inches in diameter, is accurately described. The circumference of the circle to be divided into five equal portions, and these subdivided into tenths. A pointer, three inches long from the centre, to be attached directly to the "crank" or "tangent arm" by means of a small vertical pin passing through a hole in the glass in the centre of the dial.

A Specification of a 100-Light Dry Test Meter for the Standards Department of the Board of Trade.

The meter to deliver 2·5 cubic feet at each revolution or complete action, and to be of the following dimensions:—

	ft.	in.
Height, to top of unions - - -	3	4¾
Depth, from back to front - - -	1	11
Width, from exterior rings of unions -	2	8⅜

The external case to be made of 18 B. W. gauge best charcoal tinned iron.

All the parts that come in contact with the gas to be made of anti-corrosive material, and of such suitable alloys as the different working parts require.

The inlet and outlet pipes to be 2 in.

The top of the meter to be made of strong plate glass, on which a circular dial is accurately described. The circumference of the circle to be divided into five equal parts, and these subdivided into ten. A pointer to be attached directly to the "crank" or "tangent arm" by means of a small vertical pin passing through a hole in the glass in the centre of the dial.

Explanatory Statement of the Construction of the Standard Dry Test Meters.

To explain the construction and mode of action of the meters ordered by the Board of Trade, the annexed diagram of a 10-light meter of George Glover & Co. will suffice.

A. Inlet.
B. Outlet.
C. Upper chamber.
D. D. Movable discs.
E. E. Outlet pipes from centre "ports" of valves.
F. F. Pipes connected with interior chambers.
G. G. T-piece connecting discs with driving rods.
H. H. Guides to preserve parallel motion of discs.
I. Index.
K. K. K. K. Arms connecting driving rods with crank.
L. L. Stuffing boxes, to prevent escape of gas, round the rods, from the measuring chambers.
M. Slotted "tangent" of crank.
N. Pin in slot of "tangent" to regulate the travel of the discs.
O. Crank for opening and closing valves.
P. P. Exterior measuring chambers.
Q. Q. Interior ditto.

R. R. Driving rods.
S. Wheel and spindle communicating the revolutions of the crank to the index.
T. T. Valve plate.
V. V'. Valves for admitting the gas alternately to the interior and exterior measuring chambers.

The principle on which the meter acts is as follows:—

The gas enters the meter at the inlet pipe A. and passes into the upper chamber C. at the circular inlet hole A^1 in the valve plate T. T. It then passes alternately down the openings, marked 1 and 3, in the valve gratings to the interior and exterior measuring chambers, and by its pressure on the discs D. D. causes them to travel alternately backwards and forwards, the extent of the travel being regulated by the distance of the pin N. from its axis. The discs at each complete action displacing a uniform quantity of gas. The volume being equal to the area of the disc multiplied by the distance travelled. These two remaining constant the measurement remains uniform, *i.e.* correct, after the meter has been once regulated by the Standard Gasometer.

The gas, which is being displaced by the discs, passes up alternately one or other of the two ports of the valve grating marked 1 and 3, which ports, by the action of the crank O. on the cover of the D slide-valve, are brought alternately into connexion with the centre port (marked 2) of grating which is connected with the tubes E. E. leading to the outlet of the meter B.

The modification required to convert our ordinary dry meter into an accurate test meter is as follows:—

A plate glass top is put on the meter; on it is engraved a circle (with subdivisions) to record the capacity of the meter at one revolution or complete action. At the same time, a pointer is rigidly connected with the crank of the meter to indicate on the engraved circle the whole or any part of a single revolution of the meter. Of course a dry meter requires to be made with great care and precision to admit of the pointer being placed in direct connexion with the crank tangent, and moving parts of the meter.

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13. *From Mr. Geo. Glover. On the Advantages of his Patent Dry Test Meter.*

Ranelagh Works, Pimlico,
Sir, 22nd Dec. 1870.

It is obviously unnecessary that I should reply in detail to the various objections which have been raised against a dry test meter.

See p. 144. The result of experiments carefully conducted for your Department, and to be printed amongst the papers appended to the Reports of the Standards Commission, affords conclusive evidence of the greater accuracy of the dry meter sent by my firm to your office than of the wet meter that was subjected to this comparative trial. I may be permitted to remind you that the test meter sent to you had been made six years previously, and had only been in occasional use during that long period.

I beg to state that most of the objections to the dry meter are theoretical, and do not apply to the above-mentioned test meter as the result has shown. The disc which remains of a determinate size and travels backwards and forwards through a fixed or invariable space, displaces and must displace a uniform quantity of gas during each alternate movement. It is an error to suppose that the leather of the diaphragm enters into the question of the measurement. In dry meters of oblique action with triangular doors hinged and connected with leather the case is widely different. The leather in such meters if affected by moisture or dryness enlarges or lessens the size of the measuring chambers; whereas in my meters such effects cannot occur, for the leather being stretched in no part of the action of the meter performs no direct function in the measurement of the gas.

As two test meters have now been furnished severally of 20 and 100 lights, to the Board of Trade, which are therefore in your own hands, I confidently trust the results obtained from them, and the use of similar meters in practice, will clearly establish the superior accuracy and utility of dry test meters compared with wet ones; and also that the lapse of years will find the former far more reliable and convenient than the latter for testing other meters.

Dry meters have the great additional advantage that they cannot be tampered with in their measurement without showing evident signs of having been so. The breaking of the seals, &c. are such signs, whereas the mere change of level or the variation in the quantity of water will affect the measurement of wet meters.

There is no absolute connection in the wet meter, as in the dry meter, between the gas which passes through and the quantity registered.

It is sufficient to say in conclusion that the practical performances of the test meter lent by my firm may be taken as a sufficient answer to the theoretical objections which have been urged against dry test meters.

I may further add that the dry meter is not only more portable for the purposes of a test meter, but can be safely handled and carried from place to place without injury.

Thus whether as respects accuracy of measurement, correct registration, convenience of transport, facility of use, greater durability and economy, along with absence of temptation to dishonesty, its superiority is apparent. And I am prepared to leave the proof of these facts to the practical test of experiment with the gas measuring standards under your directions.

I am, &c.
H. W. Chisholm, Esq., Geo. Glover.
Warden of the Standards.

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14. *From Mr. F. W. Hartley on the best Method of using a Standard Test Gas Meter, and the adjustment of its water line. Dated 22nd Dec. 1870.*

55, Millbank Street, Westminster, London,
Sir, Dec. 22nd, 1870.

In the conversation which I had the pleasure of holding with you a few days since, two questions were raised; the first was—

> The difference between the conditions under which a *gasholder* and a *gas meter* are capable of measuring gas;

and the second—

> The conditions under which a *test* or *standard wet gas meter* may be employed, so as to secure the closest approximation to true measurement.

I now beg to submit to you, in writing, my views on these questions.

A gasholder of the usual construction is capable of measuring volumes of gas while in a state of compression equal to, exceeding, or in deficit of the compression of the atmosphere, these different states of compression being obtainable by the employment of such a number of moveable weights acting in opposition to the weight of the bell as will suffice to equipoise it exactly, or to dispose it to fall or to rise with any desired degree of force.

When two gasholders, A. and B., are compared as to their capacities, by passing the gaseous contents of A. into B. and *vice versâ*, it is proper, before observing their agreement or degree of difference, to bring *both* into equipoise, that is, into such a condition that neither shall have any tendency to rise or to fall, as by this means it will be better ascertained whether there is any undue resistance to motion in one or in both, and also whether they are equally counterpoised and compensated by their counterpoise and compensating weights.

Two gasholders, each working with the minimum friction and equally counterpoised and compensated, may, it is evident, have their relative capacities determined by the use of gas in any degree of compression or of rarefaction.

As a theoretical proposition it may be said that a gasholder is an instrument capable of measuring gas independently of the influence of friction, and that resistance or friction in instruments capable of holding and of measuring gas tends, generally, to the compression of gaseous volumes.

A gas meter differs widely from a gasholder in its mode of measurement, in a meter, friction or resistance to motion is an essential element to a sensible and important extent. A meter requires power or force to drive it; this force must be derived from the gas to be measured, so that the gas must be delivered into and pass through the measuring chambers under some sensible pressure, *i.e.*, in a state of compression greater than that of the atmosphere, and it can only be measured while in this greater condition of compression.

To attempt to measure the capacity of a meter by the aid of a gasholder under atmospheric pressure only would be erroneous. For, if a gasholder be charged, say with 11 cubic feet of gas while exactly counterbalanced; it will be needful to apply pressure to the contained gas in order to give it a force to overcome the resistance of the meter; the gas will be compressed, and in this condition pass

Appendix VIII.—*continued.*

through the meter. To produce the effect of the passage of 10 cubic feet on the index of the meter, *more* than 10 cubic feet of the original volume in the gasholder under atmospheric pressure must be used. Hence, on restoring the gasholder to a state of equilibrium, the meter would be made to appear to be *slow.*

The correct method of comparison is as follows:—Connect by means of a pipe the outlet of the gasholder to the inlet of the meter. Close the outlet of the meter by means of a cock. Charge the gasholder, while acting with sufficient downward force (say equal to the supporting a column of water half an inch in height), with gas. Discharge sufficient gas through the meter to cause its index to indicate the passage of, say 10 cubic feet. Then shut off the flow by the cock on the outlet of the meter, and under this condition note the quantity delivered from the gasholder.

The subdivisions of a cubic foot, as indicated on the index, must be observed during the transmission of the 10 cubic feet of gas. The meter (and flow of gas) may be stopped whenever desired by means of the cock above mentioned.

In respect to the second question expressed at the beginning of this letter, I have to remark that the water level at which a wet test meter shall measure truly may be fixed under two conditions:—

1st. By charging the meter *with* water, experimentally determining its correct measurement when working at its normal speed, and then defining, while the meter is not in action, and while the atmospheric pressure only is acting within it, the height for the water by engraved lines or by other suitable means, on the water line gauges.

The 20 ft. standard test meter is constructed for this method of adjustment, the gas being admitted to the water line gauges under the outlet pressure.

2nd. By experimentally determining the correctness of the meter's measurement at its normal or any convenient speed; and by defining, while the meter is working at the same speed, the height for the water on the gauges.

The gauges must be acted upon by the pressure of the inlet gas. The 100 ft. standard test meter will be so constructed that the inlet gas may enter one, if not all, the gauges.

A meter adjusted in the first-described method will be slightly in error in its measurement when working above or below its normal speed, but the error is not likely in practice to exceed *one per cent.* The errors due to varying speeds may be experimentally determined and tabulated, and the table used to correct measurements when the meter is employed.

The method of using a test meter adjusted according to the first method is described in the extract on "Gas Meter Testing," by the writer, which has already been laid before the Standards Commission, the test meter being connected either to the inlet or to the outlet of the meter to be tested, in most cases perhaps preferably to the outlet. See p. 139.

A test meter adjusted in accordance with the second method could be made always to give true measurement at whatever speed it was worked. The proceedings necessary to secure such uniformly accurate measurement being as follows:—Charge the test meter with water nearly or quite to the defined water line on the gauges, connect together in the needful manner the test meter and the meter to be tested. Pass gas through both meters, and adjust the flow to any desired or possible rate by opening the cock on the outlet of the test meter to the requisite extent. With the gas thus passing, add or subtract water from the test meter until the water coincides in height with the marked lines on the gauges. Observe the position of the lever of the outlet cock on the quadrant scale. Shut off the cock. Adjust the moveable hand of the test meter to the zero of the index scale or dial. Note the registration of the index of the meter to be tested. Turn on the outlet cock of the test meter until the lever covers the same graduation of the quadrant scale as at first. When sufficient gas has passed, shut the outlet cock as before, and note the registration of both meters.

The gas entering the gauge at the same pressure as it acts upon the measuring wheel of the meter causes the water to stand at the same level in the gauge as it does within the wheel itself when the latter is in motion; and it is evident that if the water be always adjusted to the same line within the wheel, it matters nothing whether the wheel revolves at the rate of one or one hundred revolutions per hour. More water will, however, be needed in the meter when worked at high speeds than when worked at low speeds, in order to provide for the greater difference in the water levels within and without the wheel.

All large meters, in which the water level is defined by gauges, should have the inlet pressure of the gas acting on the gauges, and the water line should be defined while the meter is in motion.

The advantages of indicating the "working" water line are, that an inspector could test a wet meter at any convenient speed (marking its water line while in action), disconnect his test meter, and set the tested meter, if fixed, in full action, and then add the needful quantity of water to make it measure correctly. If any one else fixed the meter, he would be instructed to finally charge the meter to the true level, while in full action. Further, on an inspection of the water line when the meter was in action would show whether it contained a proper quantity of water. On the other method of adjustment the gas must be shut off and the atmospheric pressure only be allowed to act upon the inside of a meter when it is desired to examine and adjust the water line.

There is a little extra trouble, but no practical difficulty, in adjusting the level while the meter is working, and the writer has practiced this method for a number of years in respect to large meters in use on the works of gas companies.

I remain, &c.
H. W. Chisholm, Esq., F. W. Hartley.
Warden of the Standards.

APPENDIX IX.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—On the LENGTH of the FRENCH MÈTRE in relation to the BRITISH IMPERIAL STANDARD of LENGTH.

CONTENTS.

Page
Resolution of House of Commons, 15 March 1816 - - 148
Comparison of Mètre and Yard entrusted to Royal Society; steps taken by them - - - - - - "
Measurement based on Shuckburgh scale - - - 149
Consequent computation of the length of the Mètre, by Captain Kater in 1818 - - - - - - "
Effect of difference of French and British Standard temperatures - - - - - - - "
Previous computation of length of the Mètre by the French National Institute in 1802 - - - - - "
Further determination of length of the Mètre by Mr. Baily in 1835 - - - - - - - - "
Co-efficient of expansion of platinum - - - "
" " brass - - - "
Mr. Sheepshanks' observations of the expansion of metals in 1853 - - - - - - - - "
Captain Clarke's observations of the expansion of metals in 1865 - - - - - - - 150
Latest comparisons of Standards of Length, and of the Mètre, by Captain Clarke - - - - - "
His computation of the length of the Toise of Peru - "
And of the Mètre as derived from the Toise - - "
Verified by comparison of the Royal Society's platinum mètre "
Length of Mètre if raised to British Standard Temperature of 62° Fahr. - - - - - - - "
Question of constant length of a Standard bar at a stated temperature - - - - - - - "
Comparison of Captain Clarke's observations of length of Metallic Standards with those of Mr. Sheepshanks - "
Summary of several computations of length of the Mètre - 151
Authoritative character of the Shuckburgh scale, as the Scientific Standard, now lost - - - - - "
Question of Credit of Astronomical Society's Tubular Scale
Suggestion of adopting Captain Clarke's computation of the length of the Mètre on the new bar, with the sub-divided Yard, for the Standards Department - - - "
Page
And of official comparison of this Mètre with the French Standard - - - - - - - 151
General question of internal changes in Metallic Standards of Length - - - - - - - "
Difference of legal and scientific French Mètre - - "
The legal French Mètre - - - - - - "
Its definition to be found in Law of 10 December 1799 - "
Its length declared in Art. 1 - - - - - "
Definitive Standards of Length and Weight constituted by Art. 2 - - - - - - - - "
French Standard Temperature adopted by Commission under Art. 3 - - - - - - - "
Description of the French Standard Platinum Mètre, and the Toise of Peru - - - - - - 152
The Mètre and Kilogramme des Archives, established as primary Metric Standards - - - - - "
In fact and in law the Mètre not a Scientific but a Material Standard - - - - - - - "
Provision for restoring these Metric Standards if lost or destroyed - - - - - - - "
Length of Legal Mètre not scientifically exact - - "
How length determined; even if exact, not an Universal, but a Local Standard Measure of Length - - "
Latest computation of length of Scientific Mètre by Captain Clarke - - - - - - - - "
Final Summary of computations of length of the Mètre, *de jure*, *de facto*, and *de scientiâ*, in terms of the British Standard - - - - - - - - "

(A.) Captain Kater's detailed Account of his comparison of the French Mètre with the British Standard of Length. Extract Phil. Trans., 1818 - - - - - 153

POSTSCRIPT.—Comparison of the Mètre by Mr. Hassler, in America - - - - - - - 155

Resolution of House of Commons, 15th March 1816.

On 15th March 1816, upon the motion of Mr. Davies Gilbert, a resolution of the House of Commons was passed for taking the necessary steps to compare the French mètre with the British standard measure of length. The consequent proceedings may be seen from the following extracts from the Commons Journals:—

"15th March 1816.—Resolved, that an humble address be presented to His Royal Highness the Prince Regent, that he will be graciously pleased to give directions 'for comparing the standard measure in possession of this House with the ten-millionth part of the quadrant of the meridian now used as the basis of linear measure on the continent of Europe.'

"19th March.—Reply that His Royal Highness would give directions as desired by the said address.

"14th May 1817.—Petition of President and Council of Royal Society, presented and read, 'that the House did, on 15th March 1816, vote an address to His Royal Highness the Prince Regent for the purpose of ascertaining the basis of linear measure; and that on the 19th of the same month His Royal Highness was graciously pleased to acquaint the House that he would give directions accordingly, and that it is expedient, in order to effect this purpose, that the standard measure in the possession of the House should be compared with other measures of this kingdom, and also with the basis of linear measure now used on the continent of Europe; and that the petitioners therefore, having received directions from one of His Majesty's Principal Secretaries of State to co-operate in this comparison, we humbly pray that the House will be pleased to direct that the standard measure belonging to the House may be delivered to their clerk for the purpose aforesaid.'

"Ordered, that the said petition do lie on the table.

"Ordered, that the clerk of this House do deliver the said standard measure to the clerk of the Royal Society accordingly."

Compari of Mètre and Yar entruste to Royal Society. Steps tak by them.

The comparison between the Standard yard and the Standard metre was entrusted by the Government to the Royal Society, who appointed a Committee for that object, and requested the assistance of the Royal Academy of Sciences at Paris in procuring a Standard mètre. Two mètres of platinum were accordingly made under the inspection of M. Arago, and were delivered by him to the Royal Society. One was a bar of platinum about 41 inches long, 1 inch wide, and 0·25 inch thick, being a *mètre à traits*, or line standard; the length of the mètre being defined by two very fine lines cut upon it. It was found by M. Arago to be less than a Standard mètre by 1·759 millimetre, or 0·00069 inch. The other was a similar bar of platinum, of the same width, but 0·3 inch thick, and constituting an end standard, or *mètre à bouts*, the terminating planes being supposed to be perfectly parallel, and the distance between them the exact length of the mètre.

Phil. T 1818, p.

These mètres were given into the charge of Captain Kater, who had undertaken the measuring observations on behalf of the Committee. In order to assist the comparison, Bird's Parliamentary Standard Yard of 1758 was also entrusted to the Royal Society; but Captain Kater found this Standard to be "little adapted for measurements "where great precision was necessary." Bird's Standard Yard of 1760, afterwards recommended by the Commissioners of Weights and Measures, in their Second Report, dated in 1820, as the foundation of all legal weights and measures, and which was established as the new legal standard of length by the Act of 1824, was also entrusted to Captain Kater. Up to this period, the *legal* standard of length was the Exchequer yard,

Appendix IX.—*continued.*

which had been in use ever since Queen Elizabeth's reign, and was admitted to be defective and a bad standard.

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As the standard yard alone was insufficient for determining the length of the mètre in relation to it, the actual measurement was based upon the length of the yard as shown by Sir George Shuckburgh's Standard Scale, in possession of the Royal Society, and which was considered by Kater as a scientific representative of the national standard of length. This was a brass scale of 5 feet, divided into inches. The length of the first 36 inches was subsequently compared by Kater, in 1821, with Bird's Standard of 1760, and he stated that the latter "differs so little, if at all, from that of Sir "George Shuckburgh that they may for every purpose "be considered as perfectly identical; and this agree"ment is perfectly convenient, because the length of "the mètre having been determined by comparison "with Sir George Shuckburgh's scale, and a fac-simile "of it made by Mr. Troughton for Prof. Pictet, all "measures on the continent are converted into English "measure by reference to Sir G. Shuckburgh's "Standard."

il. Trans.,
1, p. 92.

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The length of the French mètre, expressed in inches of the British standard yard, was accordingly computed, and was stated by Captain Kater in the Philosophical Transactions for 1818, an extract of which is appended (A.), to be 39·37079 inches, being the mean of the two platinum mètres, the length of the line standard being found to be 39·37076 inches, and that of the end standard 39·37081 inches. The equivalent thus determined was adopted by the Royal Commission on Weights and Measures in their Second Report, which was laid before the House of Commons in 1820. The same equivalent was quoted by Captain Kater in his "Account of the "new Standards of Weights and Measures," read before the Royal Society in 1825, and has since been generally accepted both in England and in France.* In the Annuary of the Bureau des Longitudes the mètre is declared to be equal to 39·37079 British Imperial standard inches. The mètre is thus equal to 1·09363 yard. In the first Metric Bill of 1863, as introduced by Mr. Ewart and the advocates of the metric system, exactly the same equivalent of 39·37079 inches was assigned to the mètre. In the second Metric Bill, introduced in 1864, the mètre was declared to be equal to 39·371 inches; and in the schedule annexed to the amended Bill, subsequently passed as the Metric Act, 1864, the legal equivalent of the mètre was declared to be, and now is, 39·3708 inches, being substantially according to Captain Kater's computation in 1818.

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This result is obtained by taking the mètre at the French standard temperature of 32° Fahrenheit, and the yard at the British standard temperature of 62° Fahrenheit. The consequence of this difference in the standard temperatures of the two countries is, that in comparing their standards, the relative length cannot be determined by observations only, but must be the result of computations depending upon the relative expansions of the metallic standards compared.

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Base du
Syst,
Mètr, vol.
iii., p. 463.

A previous computation of the length of the mètre, in terms of the British standard, had been made by the French National Institute in 1802, an account of which appears in vol. 3 of "*Base du Système Métrique.*" Comparisons of the two standard mètres à bout of the Institute, one of platinum, the other of iron, were made with M. Pictet's copy of Sir George Shuckburgh's brass standard scale, the two scales having been declared identical by the maker, Mr. Troughton. A microscopical apparatus, also constructed for M. Pictet by Mr. Troughton, was used for the comparison. The result was that at equal temperatures of 12·75 centigrade (54·95° Fahr.) the platinum mètre was found =39·3781 inches, and the iron mètre = 39·3795 inches. By taking Borda's computation of the expansion of the metals, from experiments then made, and all the standards being reduced to 32° Fahr., the platinum mètre was declared = 39·382755 inches, and the iron mètre = 39·382649, and the difference of 0·000106 was considered too small to deserve notice. To complete this comparison, the *British* standard should have been raised to its temperature of 62° Fahr., making a difference for 30° Fahr. of 0·011696 inch, and allowing also for the error of 0·00005 inch, in the line showing 39·4 inches of Sir George Shuckburgh's scale, as subsequently found by Captain Kater, the final result of this comparison would appear to be, the platinum mètre = 39·371009 inches, and the iron mètre = 39·370903 inches.

Further determination of the length of the mètre by Mr. Baily in 1835.

Mem. Astron. Soc., vol. 9, p. 133 -138.

In 1835 a further determination of the length of the mètre was made by Mr. Baily, and is recorded in vol. 9 of the Memoirs of the Astronomical Society. He compared the two platinum mètres of the Royal Society with the tubular scale of the Astronomical Society, and found the mètre à traits = 39·369678 inches, and the mètre à bouts = 39·369375 inches of this standard. Allowing for the corresponding proportion of Mr. Baily's stated excess of the tubular scale over the standard yard (36 inches = standard yard + 0·000376 inches) the mètre à traits would then be equal to 39·37009 inches, and the mètre à bouts to 39·370053 inches of the Imperial standard of that time. Mr. Baily accounts for the difference between his measurement of the mètre and Captain Kater's, by assigning an error in excess of 0·000407 inch in that part of Sir G. Shuckburgh's scale used by Kater, and a further excess of 0·00035 inch, caused by Kater's insufficient data of the expansion of brass.

Co-efficient of expansion of platinum.

Miller, p. 787.

It may here be stated that in all the computations of the length of the mètre referred to in this paper, Borda's co-efficient of the expansion of platinum has been taken, viz., 0·00000476 parts of its length for 1° Fahr. But Borda's computation has not always been accepted as accurate. Professor Miller says,* "Schumacher has given two tables of the expansion of "platinum, one calculated on the supposition that the "co-efficient of the linear expansion is 0·00000500, the "other with the co-efficient 0·00000505, as if in doubt "which deserved the preference. Steinheil adopts "0·00000476 in the reduction of the weighings of the "platinum kilogramme des archives. In comparing "the standard platinum mètre with a glass mètre, the "expansion of which was known, at temperatures, "however, not differing much from each other, he "obtained 0·00000503 for the co-efficient of expansion."

Co-efficient of expansion of brass.

The stated co-efficients of the expansion of brass for 1° Fahr. have been as follows :—

Borda,	co-efficient of expansion of	brass or latten	-	0·0000099
Kater,	„	„ brass	-	0·0000101
Baily,	„	„ „	-	0·00001048

Kater assumed the rate of 0·0000101 from its being the result of two experiments on plate brass, as he could not conveniently determine the expansion of the Shuckburgh scale. But he acknowledged that "the mean of "most of the experiments made on the expansion of "brass, gives 0·0000104." It is remarkable that Captain Kater should have been content to assume this rate of expansion in determining the relative lengths of the two standard units of length of France and Great Britain, when he had himself admitted, in a paper read before the Royal Society in the same year, upon his experiments for determining the length of the pendulum vibrating seconds that "the composition of brass is so various, "that probably no two specimens possess precisely the "same rate of expansion."

Phil. Trans., 1818, p. 60.

Mr. Sheepshanks' observations of the expansion of metals in 1853.

Airy, p. 26.

Airy, p. 61.

In the proceedings for the restoration of the standard, taken subsequently to Mr. Baily's death in 1844, the best thermometers then used were found so irregular and erroneous that it was deemed necessary "to create "an entirely new system of thermometers and to use "them in new determinations of the thermometric "expansions." The results consequent upon Mr. Sheepshanks' observations in 1853 were to determine the co-efficients of expansion for 1° Fahr. as follows :—

Bronze expands	0·000341 in.,	for 36 inches,	co-efficient of expansion.		=0·00000947
Brass -	- 0·000344	„	„	„	=0·00000956
Wrought iron	- 0·000220	„	„	„	=0·00000611
Cast iron	- 0·000198	„	„	„	=0·00000550
Cast steel	- 0·000207	„	„	„	=0·00000575

Miller, p. 786.

Professor Miller says of the expansion of brass, "the "mean rate of expansion of cast brass from 32° to "212° usually assumed 0·0000104 of its length for "1° Fahr. is considerably larger than the rate at

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* MM. Mathieu, Legendre, and Dulong made a report (of which the following is the conclusion) on M. Franceur's memoir relative to the comparison between the French mètre and the English measures. "The "proportion of the Imperial English yard to the French mètre was obtained with great precision by an intermediate comparison of the "two Standards. The mètre=39·37079 English inches, and the yard is "=0·91438348 of a mètre. The ounce was determined =31·0913 grammes, a result considered to be within two or four milligrammes of "truth."

The approbation of the Academy was conveyed to M. Franceur for solving this problem.

Journal of the Institute, Academy of Sciences, 1 Dec. 1827.

* Fahrenheit's scale is here substituted for the Centigrade, which is used by Professor Miller in his paper on the Construction of the new standard pound.

Appendix IX.—*continued.*

Similar observations by Capt. Clarke in 1865.

" ordinary atmospheric temperatures, according to the " observations of Mr, Sheepshanks, who found that at " about 62° the co-efficient of the linear expansion of " cast brass=·00000956."

From the latest observations in 1865 by Captain Clarke of the Ordnance Survey Department, to be presently referred to, he shows as the final result of his experiments on the expansion of metals, for 1° Fahr.:—

Clarke, pp. 217, 90, and 227.

Co-efficient of expansion of bronze (Baily's metal) - - - - - - = 0·0000098574
Co-efficient of expansion of cast steel - = 0·0000063529
" Swedish iron = 0·0000063580
" wrought iron = 0·0000064751

The expansion of brass is not stated by him, no bars of that metal having come under his observation.

Latest comparisons of standards of length, and of the mètre, by Capt. Clarke.

More elaborate comparisons of the standards of length in several countries, including England and France, have recently been made at the Ordnance Survey Office, Southampton, by Captain A. R. Clarke, R.E., under the direction of Colonel Sir Henry James, Director of the Ordnance Survey. An account of these comparisons and of their results was published officially in 1866, and contains the latest determination of the length of the mètre, now expressed in terms of the British standard of length, as restored and legalized by the Act of 1853. Careful comparisons of the French mètre with an authoritative copy of the new Imperial standard yard have thus for the first time been made. The copy used for these comparisons was the line standard yard, No. 55 of Swedish iron belonging to the Ordnance Survey Office.

His computation of the length of the toise of Peru.

Captain Clarke's computation of the length of the mètre was made in the first instance from comparisons, not of the mètre itself, but of authoritative representatives of the *Toise of Peru,* the French standard of length actually used for the original determination of the mètre; the French mètre being legally declared to be the measure of a bar of platinum equal, when at the temperature of melting ice, or 0° Reaumur, (32° Fahr.) to 443·296 lines (or $\frac{1}{864}$ parts) of the toise of Peru at 13° Reaumur (61·25° Fahr.).

And of the mètre as derived from the toise.

The *Ordnance toise* was first compared by Captain Clarke with the Ordnance standard yard, No. 55. The comparison was facilitated by the length of two separate standard yards being marked upon the Ordnance toise. The excess over two yards was measured by the subdivided Ordnance foot. The difference in length between the Ordnance toise and the toise of Peru was then obtained by the mean of ten series of comparisons between seven known bars (including the Ordnance toise), of one or two toises in length, among themselves, and the toise of Peru. The result was that the *toise of Peru* at 61·25° Fahr. was found to be equal to 2·13151116 yards, or 76·734402 inches; and consequently the mètre at 32° Fahr. has thus been determined equal to 1·09362311 yard, or 39·370432 inches. The probable error of this measurement is stated to be only 0·00000028 yard, or 0·00001008 inch, in excess or deficiency.

Clarke, pp. 96, 276.

Clarke, p. 280.

Verified by comparison of the Royal Society's platinum mètre.

A verification of this computation was made by a comparison with the Ordnance standard yard, of the platinum mètre à traits belonging to the Royal Society, and taken, according to M. Arago's verification, to be 0·00069 inch less than a standard mètre. As this comparison could not be directly made, it was effected by means of the *Ordnance mètre,* a bar of cast steel, upon which were lines cut on platinum pins and defining the length of a yard and a mètre. The determination of the length of the small space somewhat exceeding 3·37 inches, being the difference between the yard and the mètre, was made by comparing it with the corresponding space on the *Ordnance foot,* a wrought-iron bar, divided into inches cut upon platinum pins, the extreme inches being divided into tenths, and two tenths in each inch into hundredths. The platinum mètre à traits was thus found, when at the French standard temperature of 32° Fahr., to be equal to 1·09360478 yard, or 39·36977208 inches. By adding 0·00001924 yard, or 0·00069264 inch, the actual deficiency of this platinum mètre as determined by M. Arago, the standard mètre was found to be equal to 1·09362402 yard, or 39·37046472 inches. No probable error could be assigned to this computation, there being no way of estimating M. Arago's measurement. As the difference between this last combination and the length obtained through the toise was only 0·00000091 yard, or 0·00003276 inch, the result was considered by Captain Clarke to be an agreement equally remarkable and satisfactory.

Clarke, p. 105.

Clarke, p. 279.

Length of mètre if raised to British standard temperature of 62° Fahrenheit

It may be here added that allowing for the expansion of platinum at 0·00000476 for 1° Fahr., as determined by Borda, the expansion of the platinum mètre for 1° Fahr. would be 0·00000520 yard or 0·0001874 inch, and for 30° Fahr. 0·00015617 yard, or 0·00562215 inch. If therefore the French standard platinum mètre were raised from its temperature of 32° to the British standard temperature of 62°, it would then appear to be equal to 1·09378019 yard, or 39·37608687 inches, according to Captain Clarke's computation.

Question o constant length of a standard bar at a stated temperature.

Before, however, accepting Captain Clarke's latest determination of the length of the mètre in terms of the British Imperial standard, there is one point of some importance to be noticed, as it affects not only the accuracy of this measurement, but also the principle upon which the truth of our Imperial standard yard depends, viz., that a standard bar retains an invariable length at a stated temperature.

The question whether any changes occur in process of time in the length of metallic measuring bars, at their standard temperature, and in their co-efficients of expansion, has been recently considered in a paper by General Baayer, published at Berlin. After stating the results of accurate measurements at various periods of several Standard bars, constructed by Bessel, and formed of iron and zinc, he comes to the conclusion that *their co-efficients of expansion have materially diminished in the last* 20 *years, whilst the length of the bars at their standard temperature* has remained unchanged. A translation of General Baayer's paper will be found in Appendix X.

Comparison of Capt. Clarke's observations of length of metallic standards with those Mr. Sheepshanks'.

The Ordnance standard yard, being the copy No. 55 of the Imperial standard, when supplied to the Department, was, according to the comparisons made by the late Mr. Sheepshanks, certified to be of the standard temperature of 61·93°, or allowing for the expansion of 36 inches of wrought iron for 1° Fahr. = 0·000220 inch, its actual length would appear to have been 0·00000043 yard, or 0·0000154 inch, more than the Imperial standard. As some doubt existed as to the constancy of the co-efficient of the expansion of metals, and of the length of a metallic bar at 62°, five certified copies of the Imperial standard yard, including No. 55, were compared by Captain Clarke, with a view of ascertaining whether the differences agreed with those assigned by Mr. Sheepshanks 10 years previously. The results of these comparisons are shown together in the following table, the differences being stated in millionths of a yard:—

Airy, p. 61.

Clarke, p. 151.

—	Differences from Imperial Standard.		Difference of Capt. Clarke from Mr. Sheepshanks.
	Mr. Sheepshanks, in 1853.	Capt. Clarke, in 1864.	
Copy of Standard Yard, viz.:—			
Bronze, No. 29 - - - -	+4·58	+1·77	−2·81
Swedish Iron B., No. 55 - -	+0·43	−0·40	−0·83
Cast Steel A., No. 65 - - -	−1·28	−0·30	−0·98
Cast Steel B., No. 66 - - -	−0·65	+0·03	+0·68
Cast Steel C., No. 67 - - -	−2·69	−0·59	−2·10

It is to be noticed that Captain Clarke's computations of the length of the mètre were based upon the length of the standard yard No. 55, *as thus determined by his own observations* to be shorter by 0·00000083 yard, or 0·0000298 inch, than the standard length determined by Mr. Sheepshanks.

Appendix IX.—*continued.*

Summary of several computations of length of mètre.

The following is a summary of the several computations of the length of the mètre, at the French standard temperature of 32° Fahr., in inches of the British Imperial standard yard at 62°:—

By actual measurement of a standard mètre	1802. By the French National Institute - -	39·371009 in. 39·370903 ,,
	1818. By Captain Kater -	39·370760 ,, 39·370810 ,,
	1835. By Mr. Baily -	39·370090 ,, 39·370053 ,,
	1864. By Captain Clarke -	39·370464 ,,
Computation of the length of the legal mètre, by measurement of the toise - -	1864. By Captain Clarke -	39·370432 ,,
Generally accepted length, being the mean of Captain Kater's two computations - -		39·37079 ,,
Legal equivalent by Metric Act, 1864 - -		39·3708 ,,

Authoritative character of Shuckburgh scale, as the scientific standard, now lost.

Airy, p. 21.

Airy, p. 25.

But whatever authority the Shuckburgh scale, with which the mètre was compared both in 1802 and 1818, may formerly have possessed as "the scientific representative of the national standard of length," it has now lost its authoritative character. During the proceedings of the Commission for the restoration of the standards in 1844, "little importance was attached to "the Shuckburgh scale, on account of its imperfections, and the doubts and discordances of its comparisons." "The experiments of Mr. Baily confirmed "the remarks which originated with Captain Kater "himself, that minute circumstances, whose effect was "totally unsuspected in the earlier comparisons of "this scale, produced a disturbance in the apparent "length, which might have deranged in different "directions the results of its comparisons for physical "measures, and whose magnitude was intolerably "great; there was no security whatever that, in "retaining documentary or numerical expressions of "measure founded on this scale, we were referring to "a consistent system; in future it would be better to "lay aside this scale entirely."

Question of credit of Astronomical Society's tubular scale.

Airy, p. 25.

Airy, p. 82.

Nor was the tubular scale of the Astronomical Society, used by Mr. Baily in 1835 for his comparison of the mètre, deemed worthy of credit by the Standards Commission in 1844, in consequence of the differences found in the results of comparisons of it then made with other scales and with itself, and of the comparisons formerly made by Mr. Baily; although it appears that those differences were subsequently ascertained by the Commission to have been not so great as at first considered, when it was admitted, "that the tubular scale merits "greater credit than it obtained with the committee "and Mr. Sheepshanks."

Suggestion of adopting Captain Clarke's computation of the length of the mètre on the new bar with the subdivided yard, for the Standards Department.

Considering, therefore,—1st, that the more recent computations of Captain Clarke are the results of the most elaborate comparisons with our existing standard of length, and involve most careful observations with far more accurate thermometers than had been previously used for determining the temperature and relative expansions of the metallic standards: 2dly, the fact of his measurement of the platinum mètre of the Royal Society agreeing so nearly with the length of the legal mètre, as calculated from the French toise; 3dly, that the length of the mètre, according to its stated equivalent in the Metric Act, is to be ascertained by resorting to British Imperial measures only, and not to a material metric measure; and, consequently, that a mètre deposited in the Standards Department cannot, under the provisions of the existing law, be made available as a standard of length for commercial purposes, but only "in aid of scientific researches or "otherwise, as the Board of Trade from time to time "authorise and direct" (29 & 30 Vict. c. 82. s. 11),—it may be suggested, as a matter for the consideration of the Standards Commission, whether it be not expedient that Captain Clarke's computation, to the extent of 39·3704 British inches, be for the present adopted as the relative length of the mètre to be marked upon the bar with the new subdivided standard yard, now being constructed for the Standards Department; and that the Warden of the Standards be instructed to give directions accordingly to Messrs. Troughton and Simms. It may be inexpedient that a more minute definition of the length of the mètre should be adopted at the present time, when doubts exist of the constancy of the length of the metallic bars constituting both British and French standards at a stated temperature.

And of official comparison of this mètre with the French Standard.

Upon the completion of the new subdivided standard yard, with the length of the mètre thus marked upon it, it may remain for the Commission to consider how far it may be desirable that the most authoritative verification of the mètre thus furnished to the Standards Department should be officially and accurately made, by comparing it with the primary French Standard mètre or the French official standard.

General question of internal changes in metallic standards of length.

As affecting the general question whether any internal change occurs in metallic standards of length, or in the co-efficients of their expansion, it may hereafter be deemed of importance to ascertain whether the same differences now appear to exist between the Imperial standard of length and its Parliamentary and the official copies, as were assigned by the late Mr. Sheepshanks.

Difference of legal and scientific French mètre.

One important point remains to be noticed, the difference between the legal French mètre, and the true mètre or the actual measure of the ten millionth part of the meridian quadrant passing through France.

The legal French mètre.

First, as to the legal French mètre.

Barny's Traite Historique des Poids et Mesures, Edit. 1863, p. 93.

The existing French law of weights and measures is that of 4th July 1837. A table of legal measures is appended to this law, constituting a decimal scale of multiples and parts of each unit of length, superficial measure, measures of capacity and solidity, weight, and money. To each specified *decimal* weight and measure of capacity is to be added its double and its half. The mètre is defined as the fundamental unit of weights and measures, the ten millionth part of the quarter of the terrestrial meridian. ("Unité fondamentale des "poids et mesures, dix-millionième partie du quart du "méridien terrestre.)"

Its definition to be found in law of 9th Dec. 1799.

The French code of weights and measures is contained in this law of 4th July 1837, and in the two previous laws of 7th April 1795 (18 Germinal, An. III.), and 9th December 1799 (19 Frimaire, An. VIII.), which are incorporated with it. The table of legal weights and measures annexed to the law of 1837 is declared to be taken from the law of 1799, and by Art. 3 of the law of 1837 the weights and measures established by the laws of 1795 and 1799 are constituted those of the decimal metric system. As the length of the mètre defined by the law of 1795 was altered by the law of 1799, its legal definition is therefore to be looked for in this later law.

Its length declared in Art. 1. Barny, p. 7.

Art. 1 of the law of 1799, definitely fixes the length of the mètre forming the ten-millionth part of the arc of the terrestrial meridian comprised between the north pole and the equator, in its relation to the ancient measures, at 3 feet, 11·296 lines.

"La dite longueur, formant la dix-millionième partie de l'arc du méridien terrestre compris entre la pôle nord et l'equateur, est définitivement fixeé, dans son rapport avec les anciennes mesures, à trois pieds, onze lignes deux cent quatre-vingt-seize millièmes."

The toise was the unit of the ancient measure of length in France. It contained six feet, the foot contained 12 inches, and the inch 12 lines. The mètre was thus made equal to 443·296 lines of the toise.

Definitive standards of length and weight constituted by Art. 2.

By Art. 2 of the law of 1799, the mètre and the kilogramme of platinum, deposited with the Corps Législatif by the National Institute of Sciences and Arts on the previous 22nd June, (4th Messidor,) were constituted the definitive standards of measures of length and of weight in the whole of France.

"Le mètre et le kilogramme en platine, déposes le 4 Messidor dernier au Corps Législatif par l'Institut National des Sciences et des Arts, sont les étalons définitifs des mesures de longueur et de poids dans toute la France."

French standard temperature adopted by Commission under Art. 3.

Barny, p. 49.

Base du Syst. Metr., vol. 3, p. 564.

In neither of these laws constituting the French code of weights and measures is any mention made of the temperature at which this standard platinum mètre defines the length of the legal mètre. But Art. 3 of the law of 1795, in pursuance of which this platinum mètre was constructed, directs that the standards be executed with the greatest precision, according to the experience and observations of the Commission charged with its determination, and that it be deposited with the Corps Législatif, together with a description of the operations which have served to determine it. In their report made accordingly, the Commission stated that the temperature of melting ice, being a constant and invariable temperature, and constituting *zero* of their thermometers, had been adopted as that at which the platinum mètre was equal to 443·296 lines of the toise

Appendix IX.—*continued.*

of Peru, this toise being at 16·25° of the centigrade thermometer (61·25° Fahr.).

Description of the French standard platinum mètre. Vol.iii.p.466. p. 698.

Neither the exact form nor dimensions of the platinum standard French mètre are given in the "Base du Système Métrique;" but this standard is in fact an end measure, or standard *à bouts*, and it is stated that the length of the mètre is shown by the distance between the extremities of the bar, the measure being taken in the axis of the mètre and at the middle of its section. A fuller description of this standard metre is given by Steinheil (Abhandlungen der K. Akademie des Wissenschaften zu München, B. 4), in the following terms:—

"The platinum mètre des archives is in the form of a parallelopiped, and its length in its greatest axis, at 0°, is declared to be the mètre. This platinum bar is about 25 millimètres (0·984 inch), in breadth, and about 4 millimètres (0·157 inch in thickness)."

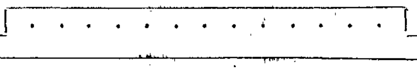
Steinheil adds:—

"The end surfaces of the mètre are not well finished, the file marks being still visible. There are also many small depressions made (Vertiefungen eingedrückt) at the spot where the comparing apparatus has been placed, and which are the result of previous comparing operations."

And of the toise of Peru.

Ibid, p. 680.

The form of the iron bar, the toise of Peru, or of the Academy, which was the ancient French standard of length, is stated in the "Base du Système Metrique" to be as follow:—



The length of the toise being taken from *a* to *b*, about a line (1½ inch) above the re-entring angle of the bar.

The mètre and kilogramme des archives established as primary metric standards.

By the law of France therefore these two platinum standards, the mètre and the kilogramme, thus deposited with the archives of the Empire, are established as the primary standards by which all the metric weights and measures of France must be regulated. And this standard mètre is legally declared to be equal to the ten-millionth part of the arc of the meridian between the north pole and the equator, and equal to 443·296 lines of the ancient standard, the toise of Peru.

In fact and in law the mètre not a scientific but a material standard.

The length of the mètre is thus definitely fixed, both legally and practically; and whether *in fact* this length is or is not equal to the ten-millionth part of the quadrant of the meridian passing through France, *in law* it is so. So long as this law remains unaltered, the French system of weights and measures, notwithstanding that it is declared to be, and is *theoretically* based upon a scientific unit or natural constant, is really and truly based upon a similar foundation to our own system in Great Britain, on certain primary metallic standards of length and of weight deposited in a specified place.

Provision for restoring these metric standards, if lost or destroyed.

There is no direct provision of law for restoring these metric standards if lost or destroyed, but this contingency was not overlooked in the report of the Commission. As the kilogramme, or standard of weight was derived from the mètre, the restoration of the mètre only as a last resort would be requisite. By way of precaution, several principal copies of the standard mètre and kilogramme was constructed and accurately verified; and even in the improbable event of all these copies being lost or destroyed, as well as the authoritative toise standard, from which the mètre was constructed, it was considered by the Commission that it would be unnecessary to revert to the difficult and delicate operation of again measuring an arc of the meridian, as the length of the mètre could be determined with sufficient exactness by means of a pendulum beating seconds in a specified place; that this indeed became a secondary scientific and natural unit. It is, however, now well known that this mode of restoring a standard of length has since been proved to be impracticable.

Length of legal mètre not scientifically exact.

But in point of fact, it is now acknowledged that recent measurements and calculations have proved the length assigned by law to the mètre, *not* to be the ten millionth part of the quadrant of the meridian. M. Barny, the *Verificateur en chef des Poids et Mesures* in France, admits in his work published in 1863—

Barny, p. 79.

"It is certain that if it were possible to prolong the measure of the meridian to the equator and the north pole, the result would be a mètre immensely different from the legal mètre. Our legal mètre is then in reality, notwithstanding all the care taken, the works done, the enormous sums expended, only a conventional measure, and not depending upon anything mathematically positive."

How length determined. Even if exact, not a universal but a local standard of length.

Sir J. Herschel, the Yard, Pendulum, and Mètre, p. 16.

The length of the quadrant of the meridian from which the mètre was taken, was determined to be 5,132,430 toises. This was the calculated result of the measurement of little more than one-tenth of the whole distance, being 9⅔ degrees extending from Dunkirk to Montjouy, towards Barcelona. Even if this computation were correct, it has been shown that as the equator is not a perfect circle, but slightly elliptic, the meridians of places differing in longitude are not all of the same length. The mètre therefore, if exactly the ten-millionth part of the quadrant of the meridian passing through France, would be, scientifically speaking, a local and national not an universal measure.

Latest computation of length of scientific mètre by Captain Clarke.

Herschel, p. 24.

But it has been already shown that it does not represent this exact proportion. The latest computations of the length of the quadrant of the meridian have been made by Captain Clarke, who has determined the figure and dimensions of the earth, his results being derived from the combination of all the separate measurements of arcs of meridians in Peru, France, Prussia, Russia, the Cape of Good Hope, India, and the United Kingdom. His memoir has been described by Sir John Herschel, as—

"By far the most complete and comprehensive discussion which the subject of the earth's figure has yet received, and must be held as the ultimatum of what scientific calculation is yet enabled to exhibit as to its true dimensions and form."

Clarke, p. 285.

Captain Clarke gives the length of the meridian quadrant passing through France as 10,001,472·5 mètres, and that of the minimum quadrant, in longitude 105° 34′ as 10,000,024·5 mètres. The true mathematical mètre, or the ten-millionth part of the true measure of the meridian quadrant passing through France, would therefore appear to exceed the legal mètre by 0·000161 yard, or 0·005797 inch, and to be equal to 1·093784146 yards, or 39·376229 British inches. It is remarkable that this measure would be very nearly the length of the platinum standard mètre, if its standard temperature of 32° Fahr. were raised to the British standard temperature of 62° (*see* page 147).

Final summary of computations of length of the mètre.

It remains only to recapitulate as a final summary the length, in terms of the British Imperial standard at 62°, of the French mètre at 32° Fahr., according to the following definitions and computations:

1. The British equivalent *de jure* of the mètre as established by the law of France, declared by the Metric Act, 1864, according to Capt. Kater's measurement, =39·3708 inches.

2. The British equivalent *de facto* as determined from the latest and most accurate comparison of the mètre with the Imperial standard by Captain Clarke of the Ordnance Survey Department, =39·3704 inches.

3. The British equivalent of the mètre *de scientiâ*, or of the length of the theoretical mètre, being the ten-millionth part of the meridian quadrant passing through France, according to the most authoritative measurement also determined by Captain Clarke, =39·3762 inches.

H. W. Chisholm,
Warden.

Standards Department,
6th July 1867.

Appendix IX.—*continued.*

(A.) See p. 146.

Extract from Philosophical Transactions, 1818.

On the LENGTH of the FRENCH MÈTRE estimated in parts of the ENGLISH STANDARD. By Captain HENRY KATER, F.R.S., February 5, 1818.

One of the objects of the committee of the Royal Society appointed for the purpose of determining the length of the seconds pendulum, being the comparison of the French mètre with the British standard measure, two mètres were procured from Paris for that purpose, the one made in the usual manner, and called the *mètre à bouts*, and the other a bar of platina on which the length of the mètre is shown by two very fine lines; this is named the *mètre à traits*.

Base du Syst. Metr., vol. 3, p. 694. The width of the *mètre à bouts* is one inch, and its thickness 0·3 of an inch. On one side the word "mètre" is engraved, and on the other "Fortin* à Paris." The terminating planes are supposed to be perfectly parallel, and the distance between them is the length of the mètre.

The *mètre à traits* is the same width as the *mètre à bouts*, but only a quarter of an inch thick. The lines expressing the length of the mètre are so fine that one of them is scarcely perceptible, even with the assistance of a microscope, unless the light be very favourable. The situation of the lines may however, be discovered by two strong black dots made with a graver at the extremities of each, and a fine line crosses them at right angles to indicate the parts from which the measurements are to be taken.

This mètre, previous to being brought from Paris, was compared with a standard mètre† by M. Arago with all that care and ability which he is so well known to possess, and which so delicate an operation requires. The result was that the distance between the lines was found to be less than a mètre by $\frac{17\cdot59}{1000}$ of a millimètre, or 0·00069 of an inch.

The same micrometer microscopes were used in the comparisons which I am about to detail as have been already described in my accounts of experiments on the length of the pendulum in the Philosophical Transactions of the present year; and as the length of the mètre is nearly 39·4 inches, I was enabled to refer it to the same divisions of Sir George Shuckburgh's scale as I had employed in the measurement of the pendulum.

I commenced with the *mètre à traits*. It was placed in contact with the standard scale, their surfaces being in the same plane. An excellent thermometer was laid upon the scale, and a piece of thick leather was placed upon its bulb in order to prevent its being affected by heat from the person of the observer.

The whole was suffered to remain in this state for two or three days, after which the following observations were made at various times, the microscopes being brought alternately over the mètre and the scale. The value of each division of the micrometer $\frac{1}{23363}$ of an inch.

COMPARISON of the MÈTRE À TRAITS.

Temperature.	Reading of the Micrometer at 39·4 of the Scale.	Reading of the Micrometer at the Mètre.	Divisions to be deducted from 39·4 Inches.	Distance in Inches between the Lines designating the Mètre.	Correction for Temperature in Decimals of an Inch.	Distance in Inches between the Lines designating the Mètre, the Mètre being at 32° and the Scale at 62°.
60·0	85·0	644·5	559·5	39·37606	0·00604	39·37002
60·7	75·5	639·	563·5	39·37588	0·00589	39·36999
61·7	69·2	634·	564·8	39·37583	0·00568	39·37015
62·	65·	630·5	565·5	39·37580	0·00562	39·37018
62·4	61·	629·	568·	39·37569	0·00554	39·37015
62·3	58·7	629·5	570·8	39·37557	0·00556	39·37001
62·2	58·	628·	570·	39·37560	0·00558	39·37002
62·2	59·	625·	566·	39·37577	0·00558	39·37019
62·1	59·	625·5	566·5	39·37575	0·00560	39·37015
58·8	90·	638·	548·	39·37654	0·00629	39·37025
59·	83·	637·	554·	39·37629	0·00625	39·37004
59·	82·	636·	554·	39·37629	0·00625	39·37004
59·2	83·2	632·	548·8	39·37651	0·00621	39·37030
59·1	81·	632·	551·	39·37642	0·00623	39·37019

Mean - -	39·37012
The distance between the lines designating the mètre was found by M. Arago to be *too little* by a quantity = 0·00069 of an inch - - - - - - - - -	+0·00069
The distance from zero to 39·4 of Sir G. Shuckburgh's scale is *too short* compared with the mean of its divisions by 0·00005 of an inch - - - - - - - - -	−0·00005
Hence the length of the mètre in inches of Sir G. Shuckburgh's scale is - - - -	39·37076

The comparison of the *mètre à bouts* presented considerable difficulties, which I conceive it would be of little use to detail, as the necessity of comparisons of this kind is of very rare occurrence. I shall therefore proceed to describe the method which was at last found successful.

Four rectangular pieces of brass were prepared precisely similar to those described in the account of experiments on the pendulum in the "Philosophical Transactions" before referred to. These were marked C, *c*, D, and *d*. The perfectly plane rectangular edges of the pieces C and *c* being placed in contact, and kept thus by means of a spring, the distance of the fine lines drawn on their surfaces, parallel and very near to the rectangular edges, was found to be 500·5 divisions of the micrometer; and the pieces D and *d*, being placed in like manner in contact, the distance of the lines on their surfaces estimated in the same divisions was 456·7.

The *mètre à bouts* being placed by the side of the brass scale, and in contact with it, the pieces D and *d* were applied to its extremities, the surface of the brass pieces being a little below the surface of the mètre, in order to preclude any error which might have arisen from the edges of the mètre projecting beyond its terminating planes. Each of the brass pieces was supported in this position upon a piece of lead of a sufficient thickness, and kept in close contact with the end of the mètre by means of a slight spring bearing against a pin driven perpendicularly into the lead.

In order to ensure a perfect contact between each brass piece and the terminating plane of the mètre a flat ruler of brass was laid upon the surface of the mètre so as to project beyond its extremity, and the end of the lead was elevated or depressed so that the line of light seen between the piece of brass and the ruler, the eye being level with the surface of the brass, appeared to be equal in every part; when it was inferred that the surfaces of the mètre and of the piece of brass were parallel, and consequently that their rectangular ends were perfectly in contact.

The distance between the lines on D and *d* was now taken by the microscopes, and transferred to the scale in the manner before described; and when a sufficient number of comparisons had thus been made the pieces D and *d* were exchanged for those marked C and *c*, and the observations repeated, with every precaution to ensure an accurate result, especially with respect to temperature.

The under surface of the mètre was then placed uppermost, and the apparatus being arranged as before, the same process was pursued as that which has just been described. The results are contained in the following tables :—

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* MM. Lenoir and Fortin were the constructors of the original metric standards and their principal copies. This mètre à bouts is probably an exact copy of the primary standard. (H. W. C.)

† Baily remarks (p. 89, vol. 9, Astron. Soc. Mem.) the term "*a* standard mètre" would imply that it was not "*the* standard mètre."

Appendix IX.—*continued.*

COMPARISON of the "MÈTRE À BOUTS."

The pieces D and *d* applied. Distance from D to *d*, 456·7 divisions.
The word Mètre above.

Temperature.	Reading of the Micrometer at 39·4 of the Scale.	Reading of the Micrometer at the Brass Pieces.	Difference.	Divisions to be deducted from 39·4 inches.	Length of the Mètre.	Corrections for Temperature in Decimals of an Inch.	Length of the Mètre; the Mètre being at 32°, and the Scale at 62°.
59·7	9·5	91·5	82·0	538·7	39·37694	0·00610	39·37083
54·8	38·0	97·2	59·2	515·9	39·37792	0·00713	39·37079
55·0	39·0	98·0	59·0	515·7	39·37793	0·00709	39·37084
55·1	36·2	95·0	58·8	515·5	39·37794	0·00707	39·37087
55·2	36·0	95·0	59·0	515·7	39·37793	0·00705	39·37088
						Mean - -	39·37084

The pieces C and *c* applied. Distance from C to *c*, 500·5 divisions.
The word Mètre above.

Temperature.	Reading of the Micrometer at 39·4 of the Scale.	Reading of the Micrometer at the Brass Pieces.	Difference.	Divisions to be deducted from 39·4 inches.	Length of the Mètre.	Corrections for Temperature in Decimals of an Inch.	Length of the Mètre; the Mètre being at 32°, and the Scale at 62°.
55·6	30·7	47·5	16·8	517·3	39·37786	·00696	39·37090
55·7	30·0	47·3	17·3	517·8	39·37784	·00694	39·37090
55·9	30·2	47·5	17·3	517·8	39·37784	·00690	39·37094
56·2	24·5	45·0	20·5	521·0	39·37770	·00684	39·37086
56·3	23·0	44·7	21·7	522·2	39·37765	·00681	39·37084
						Mean - -	39·37089

The pieces C and *c* applied. Distance from C to *c*, 500·5 divisions.
The word Fortin above.

Temperature.	Reading of the Micrometer at 39·4 of the Scale.	Reading of the Micrometer at the Brass Pieces.	Difference.	Divisions to be deducted from 39·4 inches.	Length of the Mètre.	Corrections for Temperature in Decimals of an Inch.	Length of the Mètre; the Mètre being at 32°, and the Scale at 62°.
56·8	15·0	37·5	22·5	523·0	39·37762	0·00671	39·37091
56·7	15·7	40·0	24·3	524·8	39·37754	0·00673	39·37081
56·8	14·7	40·5	25·8	526·3	39·37747	0·00671	39·37076
56·8	15·5	40·0	24·5	525·0	39·37753	0·00671	39·37082
56·8	15·5	40·0	24·5	525·0	39·37753	0·00671	39·37082
						Mean - -	39·37082

The pieces D and *d* applied. Distance from D to *d*, 456·7 divisions.
The word Fortin above.

Temperature.	Reading of the Micrometer at 39·4 of the Scale.	Reading of the Micrometer at the Brass Pieces.	Difference.	Divisions to be deducted from 39·4 inches.	Length of the Mètre.	Corrections for Temperature in Decimals of an Inch.	Length of the Mètre; the Mètre being at 32°, and the Scale at 62°.
55·0	35·3	93·0	57·7	514·4	39·37798	0·00709	39·37089
55·2	36·5	95·0	58·5	515·2	39·37795	0·00705	39·37090
55·2	36·0	93·0	57·0	513·7	39·37801	0·00705	39·37096
56·0	26·5	89·0	62·5	519·2	39·37778	0·00688	39·37090
56·0	23·5	87·0	63·5	520·2	39·37773	0·00688	39·37085
						Mean - -	39·37090

SUMMARY of the preceding Comparisons.

$$\text{The word ``\textit{Mètre}'' above}\left\{\begin{array}{l}\text{D and } d,\ 39{\cdot}37084\\ \text{C and } c,\ 39{\cdot}37089\end{array}\right\}\quad 39{\cdot}37087$$

$$\text{,,}\quad\text{``\textit{Fortin}''}\quad\text{,,}\quad\left\{\begin{array}{l}\text{C and } c,\ 39{\cdot}37082\\ \text{D and } d,\ 39{\cdot}07090\end{array}\right\}\quad 39{\cdot}37086$$

Mean 39·37086
Subtract for error in division of the Scale - −0·00005

Length of the *Mètre à bouts* in inches of Sir G. Shuckburgh's scale = 39·37081

The following is the manner in which the correction for temperature was obtained:—The expansion of platina according to the experiments of Borda and others is 0·00000476 parts of its length for one degree of Fahrenheit, and as this is the expansion used by the French in adjusting the length of their mètre, it must be employed on the present occasion. The mètre being taken at 32°, the expansion for the difference between this and the temperature of measurement, must be subtracted from the apparent length of the mètre. The English Standard temperature is 62°, therefore if the temperature of measurement be under this, the expansion of the scale for such difference of temperature must be deducted from the length of the mètre before obtained. These two corrections are combined in the column entitled "Correction for Temperature." Sir G. Shuckburgh's Standard scale is of cast brass, and as I could not conveniently determine its actual expansion with that degree of accuracy that would have satisfied me, I have taken for it the mean result of two experiments made on plate brass, which gave me an expansion of 0·0000101 parts of its length for 1° Fahr. The mean of most of the experiments made on the expansion of brass gives 0·0000104, and had I employed this last number instead of my own the difference in the length of the mètre would have been utterly inconsiderable.

Supposing then both mètres to be of equal authority, we have for the length of *mètre à traits*, 39·37076, and for that of the *mètre à bouts*, 39·37081 inches; the mean of which 39·37079 may be taken for the length of the mètre in inches of Sir G. Shuckburgh's standard scale when it is brought to its proper temperature.

The length of the mètre compared with Bird's Parliamentary Standard is 39·37062 inches.

Appendix IX.—*continued.*

POSTSCRIPT.

POST-SCRIPT.—Comparison of the Mètre by Mr. Hassler, in America.

SINCE writing the above paper upon the length of the French mètre and its relation to the British Imperial standard of length, an important Report upon the comparison of weights and measures of length and capacity, made in 1832 to the Senate of the United States by Mr. Hassler, then Superintendent of the Coast Survey there, and of the Standard Weights and Measures Department, has, for the first time, come under my notice.

In this Report Mr. Hassler refers in great detail to his comparisons of the French mètre with the British standard of length, and describes his method of comparisons and the result.

The standard measure of imperial length which had been adopted in the United States was one which had been procured from England, and was considered to be identical with the Shuckburgh scale, from which Captain Kater's Exchequer yard of 1824 was laid down. This was a large brass scale of 82 inches, divided upon silver into tenths of inches, and made by Troughton of London. It was purposely made of a length sufficient to take in the double mètre, yard, and toise, and was constructed in the same form and arrangement, with microscope and micrometer, as the Shuckburgh scale, which is 60 inches in length. The result of Sir G. Shuckburgh's comparisons of standards of English length measures had been to determine that 36 inches, according to the mean of his scale, were equal to 36·00023 inches of Bird's Parliamentary standard of 1758; and the results of Hassler's comparisons were to determine that 36 inches, according to the mean of the brass scale procured for the United States, were equal to 36·0002465 inches of the same parliamentary standard, thus differing only 0·0000165 inch, which he considered to be an inappreciable quantity. This brass scale was therefore adopted by Hassler as the standard unit of the British measure of length, for the purpose of ascertaining the relative length of the French mètre.

The most authoritative standard metres compared by him were as follows:—

1. An iron mètre à bouts (M^c), original standard, made by the Committee of Weights and Measures at Paris.

2. A brass mètre à bouts (M^b), made by Lenoir of Paris, the mechanician employed by the Committee of Weights and Measures for all the mechanical part of the construction and comparison of the metres. It had a certificate, dated 16 March 1813, of its comparison at the Observatory at Paris, stating it to be too short by $\frac{1}{100}$ of a millimètre, or 0·00039381 inch, according to Mr. Hassler's computation. Hassler, p. 23.

Pp. 21 and 68. 3. A platinum mètre à traits (M^p), certified by M. Arago to be $\frac{11}{1000}$ of a millimètre (or 0·00043319 *inch*, as Mr. Hassler computes), longer than the platinum mètre of the Board of Longitude. This equivalent length is also engraved on the under surface of the platinum à traits metre.

When Mr. Hassler had made a sufficient number of comparisons of these several mètres and was engaged in their reductions, he received a visit from M. Nicollet, Astronomer of the Royal Observatory of Paris, who also made a similar number of comparisons. The coincidence of the mean results of their comparisons was considered by them to be "fully satisfactory and evi-"dently within the limits of the unaccountable inci-"dental influences of the variations of temperature," and it was thought best to take the mean of both. The ultimate result is stated by Mr. Hassler to be as follows:— Pp. 29 and 71.

M^c - - - = 39·38091714 inches.
M^b (corrected for certificate) = 39·3803806 „
M^p (Do.) = 39·3804194 „

These equivalents of the mètre are given by him at the temperature of 32° Fahrenheit *for both French and English standards*. His reasons are as follows:— P. 8.

"The habit prevails in England to give the length of the metre in iron at 32°, in inches and decimals of the brass English scale at 62°. This result is evidently too much dependent on the ratio of the reduction adopted for the different expansion of the two metals by the temperature. Hence the result is too much affected by accessory calculations, and, besides, impossible to present in nature; which I consider a requisite of a result of a comparison. I have always preferred to present the comparisons at the same temperature, and selected for it the melting ice point, (32° Fahrenheit,) which is in itself a fixed point of the thermometers. Thereby the result becomes even more independent of the thermometer itself, and I made the comparisons as near to that temperature as circumstances would admit. Thence arises that the numbers will not agree with the English results of mètre comparisons, but they can be reduced."

Of the mètres thus compared by him Mr. Hassler considered M^c, or the metre of the Committee, being an authentic original, as of course the one that must be taken to state the real value of the French mètre in English inches. He observes that the copies of the mètre are shorter than the original mètre of the Committee, and adds that he has found such a result to be uniformly the case in copies of standards cut to a length. P. 72. P. 9.

The co-efficients of expansion of the several metals of the compared standards, which were adopted by Mr. Hassler, were, for brass and iron, those resulting from his own experiments made at Newark, N.J., in April 1817, in which the iron bars were of the same iron as those of the two iron mètres compared by him; for the platinum he adopted a mean between the determination of Borda and that of Troughton. P. 49.

These ratios and their amounts for the yard and mètre for 1° Fahrenheit were as follows:—

Metal.	Co-efficient of Expansion.	For 1 Yard or 36 Inches.	For 1 Mètre or 39·4 Inches.
Platinum - -	0·0000051344	0·0001848384 inch.	0·00020219327 inch.
Brass - -	0·00001050903	0·0003732508 „	0·0004138456 „
Iron - -	0·000006963535	0·00025068726 „	0·0002737190 „

Assuming the expansion to be as thus stated, the equivalents of the three mètres respectively at 32°, in terms of the British Standard at 62°, would be as follows:—

Iron mètre, M^c = 39·38091714 inches − 0·00821157 in. or 39·37270557 inches.
Brass mètre, M^b = 39·3803806 „ − 0·0124153 in. or 39·3679653 inches.
Platinum mètre, M^p = 39·3804194 inches − 0·0060658 in. or 39·3743536 inches.

These results, however, differ too much from each other, and from computations which have been generally accepted as authoritative, to be of much weight in assisting at the present time to determine the question of the actual length of the mètre in terms of the British Imperial standard of length. But they are laid before the Standards Commission as completing the information of the several computations of the length of the mètre.

Standards Department,
4th October 1867.

H. W. CHISHOLM.

APPENDIX X.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—TRANSLATION of GENERAL BAEYER'S PAPER on CHANGES in LENGTH and CO-EFFICIENTS of EXPANSION of STANDARD MEASURES of LENGTH.

In the "Monatsbericht der Königlich Preussischen "Akademie der Wissenschaften zu Berlin" of January 1867, is a report of an address by General Baeyer upon "the changes which measuring bars of iron and of zinc "undergo in process of time in their length and co-efficients of expansion." This paper has been brought by Professor Miller to the notice of the Warden of the Standards, and it appears to be desirable that it should be laid before the Standards Commission for their consideration. With this view the following translation from the German has been made, the extract from Plateau's paper being translated from the French.

H. W. CHISHOLM,
Warden.

Standards Department,
7th August 1867.

TRANSLATION of General BAEYER'S PAPER.

The four measuring bars constructed at Königsberg at the beginning of the year 1830, under Bessel's directions, for the purpose of setting out the base line for his measurement of a degree of the meridian, are of iron, about 2 toises (153·4688 British inches) long, 12 lines (1·065 inches) broad, and 3 lines (0·2664 inch thick). Upon them lie bars of zinc, half the breadth of the iron bars, and the same thickness. At one end the zinc bar is closely joined to the iron bar by soldering and screws. From this end to the other there is nothing else to connect the two bars together. Both are carefully and accurately planed, so that they touch throughout their whole length. The ordinary iron of commerce was used. The zinc for all four bars was rolled out at the zinc works in Neustadt-Eberswald in a single long piece, which was then divided by the saw into four narrower strips. It was thus considered that the uniform quality of the zinc could be relied on, whilst the same dependence cannot be placed on that of the iron.

The zinc bar serves as a metal thermometer, the iron bar as a measure of length. Wedged-shaped pieces of steel with a sharpened edge are soldered and screwed on the ends of the bars, and are so arranged that in every case a horizontal edge comes immediately over against a vertical edge. The intervals between the edges are measured by glass wedges inserted between them, which give by estimation thousandths of a line (0·001 line=0·000088 inch). A more detailed description will be found in the "Gradmessung in Ost-Preussen," § 1.

These four measuring bars have been three times fully tested with standards, that is to say, their lengths and co-efficients of expansion have been determined. The first time at Königsberg in 1834, when measuring a degree of the meridian in East Prussia (Gradmessung in Ost-Preussen, p. 32). The second time at Berlin in 1846 during the coast survey (Küsten-vermessung, p. 22). The fact, first discovered by me on this second occasion, which was announced as a conjecture, that the co-efficients of expansion of Bessel's standards had in progress of time become smaller, received full confirmation on the third comparison in 1854.

In explanation of this remarkable phenomenon of a slowly progressive diminution of the co-efficients of expansion, Plateau propounded the three following hypotheses (Compte rendu des Opérations de la Commission pour étalonner les règles, &c. Bruxelles, 1855, p. 126):

"In the first place, scientific persons are aware that the co-efficient of expansion of a simple substance is sensibly constant between 0° and 100°; but that there is an exception in the case of tempered steel, the co-efficient of expansion of which metal diminishes gradually from the first of these two temperatures to the second. This peculiarity arises from the fact that the co-efficient of expansion of untempered steel is less than that of tempered steel, and that in passing from 0° to 100° the effect of the increasing heat is to deprive tempered steel of a portion of its temper.

"Now steel is not the only substance susceptible of temper. Glass, for instance, is also tempered by sudden cooling, and it may be admitted that most metals which have been worked whilst hot and left to cool without precaution, possess also a slight degree of temper. If this be so, measuring bars exposed to changes of atmospheric temperature would be slightly affected by the increased heat each time this temperature was raised, and these small successive actions upon the metal would have little by little diminished their co-efficients of expansion.

"In the second place, certain substances have a spontaneous tendency to become in course of time crystalline. Zinc, indeed, crystallizes to a certain extent immediately after its manufacture, and wrought iron presents indications of a similar structure. But it is possible that although crystallization may not have been perfectly formed, in consequence of the rapid cooling of these metals, yet that they have an inherent tendency afterwards to become in time completely crystallized. One fact which strengthens this hypothesis is the well known effect upon the axles of locomotives after they have been some time in use. They become brittle and of a peculiarly crystalline structure. It is most probable that the concussions to which they have been exposed on railways have only assisted the natural tendency of the metal to assume this structure.

"In the third place there are found in nature substances of simple chemical composition, yet presenting crystalline forms belonging to two wholly distinct systems; and this occurs also in some substances obtained artificially.

"In this last case the two kinds of crystals are formed under different circumstances; the one for instance at a high temperature, the other at a low temperature. Now it happens that if we continue to expose to a higher temperature crystals obtained at a low temperature, or to the influence of cold crystals produced at a high temperature, a change is effected in their internal structure; they become transformed into an agglomeration of little crystals which belong to the system corresponding to the new temperature.

"Sulphur is a remarkable instance of a body thus acted upon. Crystals obtained from it by fusion, and consequently at a high temperature, are transparent; but if left exposed to ordinary temperature they become at the end of some days opaque and friable, and are then found to be composed of a multitude of small crystals belonging to a different system. Sulphate of nickel presents a similar phenomenon under inverse circumstances. Crystallized from solution in water at a low temperature, and afterwards exposed to the heat of the sun in a closed jar, it becomes transformed into a mass of small crystals of a perfectly different form. Might we not now suppose that iron and zinc, in which metals the crystalline structure is developed at a high temperature, when they begin to become quite solid, would assume a structure pertaining to a different system of crystals, if this could be produced at a low temperature; and thus, in bars exposed for a long time to ordinary temperature, the structure might pass gradually from one system to another? This hypothesis appears, however, less probable than the two preceding."

(General Baeyer continues,)

The above-mentioned three independent verifications of Bessel's standard bars gave the following results:—

1834 $E = 0{\cdot}000014851$; $Z = 0{\cdot}000041637$
1846 $E = 0{\cdot}000014161$; $Z = 0{\cdot}000040234$
1854 $E = 0{\cdot}000012700$; $Z = 0{\cdot}000036047$

Appendix X.—*continued.*

where E signifies the co-efficient of expansion of iron, being the mean result from observations of the four bars, and Z the co-efficient of expansion of zinc as the similar mean result from the four bars.

If L be put for the mean length of the four measuring bars, the comparisons at the normal temperature with the toise show;

1834 L = 1729·1167 lines, the mean error of one length being ·0034 line.

1854 L = 1729·1125 lines, the mean error of one length being ·0011 line.

Difference = 0·0042 line.

The co-efficients of expansion of the two metals have thus in process of time decidedly diminished; but the amount of diminution in the first 12 years, from 1834 to 1846, is very much less than in the succeeding 8 years, from 1846 to 1854. In the latter and shorter period, it is nearly twice as much in the iron, and nearly three times as much in the zinc, as in the first period.

All that is to be offered in explanation of this striking fact, has reference to the many changes of position of the bars, and to the frequent removals from place to place to which they have been subjected.

From the time of the first comparison at Königsberg, in June 1834, to the third comparison at Brussels, in the spring of 1854, there have been eight measurements of base lines made with these standard bars, viz.:—

1.	At Königsberg	in 1834
2.	„ Copenhagen	1838
3.	„ Upsala	1840
4.	„ Berlin	1846
5.	„ Bonn	1847
6.	„ Lommel (in Belgium)	1851
7.	„ Ostend	1853
8.	„ Strehlen (in Silesia)	1854

The bars were brought by water from Königsberg to Berlin in 1836, and in the spring of 1838 from Berlin by water through Stettin to Copenhagen; thence in 1839 by water to Stockholm, and back again in 1841 by water to Berlin. Till 1846, the bars were transported almost exclusively by water only; but from 1847 up to 1854 they were removed either by land carriage or by railway. In the spring of 1847, they were sent to Bonn in a stage waggon, and back again to Berlin by similar conveyance in August. At the end of October, a Belgian officer took them by railway to Brussels, from whence they reached Lommel, and then Ostend, and Brussels again, for the most part by rail. After the comparisons in Brussels, they went also by rail through Berlin to Silesia, and upon completion of the measurement of the base line were again returned to Berlin in the autumn of 1854. They have since remained quietly deposited in the Royal Depôt.

The bars were thus exposed to much fewer concussions in the first than in the second period, and it is not improbable that this may have been the cause of so far greater a diminution of the co-efficients of expansion during the latter period.

If the mean length of the bars be now taken into consideration, this was found at the last comparison in Brussels to be only 0·0042 line shorter than at Königsberg in 1834. Although this difference appears hardly to exceed the limits of errors of observation, it should still be particularly noticed that the latest comparison of the length must necessarily give a somewhat less result; for it will be granted that some wear would have occurred in every bar by the insertion of the glass wedges from five to six thousand times. Although the ends of the bars are of hardened steel, no one can altogether refuse to admit some little wearing away. The above mentioned small difference in itself of 0·0042 line may thus be fully explained by this small wear and by errors of observation, and we may come to the conclusion,—

The precise mean length of the measuring bars at 13° Reaumur has not altered in the 20 years from 1834 to 1854.

As a summary of the whole there is this remarkable result,—

The co-efficients of expansion of the measuring bars of iron and zinc have materially diminished in the 20 years, whilst the length of the bars at their standard temperatures has remained unchanged.

The comparisons of the measuring bars with each other and with the toise were undertaken entirely for the practical object of measuring the base line. They are therefore wholly insufficient for even attempting to afford an explanation of the above-mentioned result. It may also be added that the co-efficient of expansion of Bessel's toise was once determined by Bessel himself in the year 1837=0·00001126 (Darstellung der Untersuchungen und Maassregeln, welche durch die Einheit des Preussischen Längenmasses veranlasst wurden, von F. W. Bessel, Berlin, 1839, p. 126). It is, however, altogether unknown how and why the expansion of the toise has altered.

The foregoing remarks do not tend to explain the striking fact of the mean length of the bars, measured by the toise at its standard temperature, itself remaining unaltered from 1834 to 1854, whilst the co-efficients of expansion of the bars have materially diminished. But one remark may be made, that from a comparison of these measures of length with the toise no certain conclusion can be arrived at of their absolute unaltered condition, but only of a proportional lengthening or shortening, during the stated interval, of the toise and the bars.

A lengthening cannot, indeed, after the few facts before us, be altogether denied, but a shortening appears to be indicated by the following preponderating considerations:—

1. The diminution of the co-efficients of expansion.
2. Direct experiments, which will presently be referred to.
3. Iron and zinc, when they pass by cooling from a liquid to a solid state, become solid whilst yet at a high temperature; and even when cooled down more slowly, their atoms being restrained by the rigidity of the mass of metal, cannot approach each other so nearly as they necessarily would do in their normal state, at an ordinary temperature. The result is a condition of inward compression, which goes off either merely in course of time, or more quickly by the shocks given to the internal arrangements of the atoms corresponding to the changes of temperature, the effect being a contraction of both the iron and the zinc.

If this be correct, the precaution of always keeping a standard bar in one and the same temperature would not altogether guard against such a result; it would only serve to make the process of contraction slower.

There are two ways, one direct, the other indirect, of ascertaining a change of length in a bar. The direct way would be to measure over again the base line which had been previously measured, and with the same bar. It is obviously requisite for the object to be attained that the same measuring bar should be used. For instance, the base line at Königsberg might be again measured with Bessel's standard, by which any alteration in its length since 1834 might be discovered. In Paris, Borda's measuring bars are still ready at hand; if now the French Government would allow the base line from Melun to be again measured with it, any change in the length of Borda's bars since his time might be ascertained; by then comparing Bessel's measuring bars with Borda's, the original length of Borda's bars and of the toise of Peru might be arrived at.

Another way of ascertaining the change of length in a bar is by experiments with the pendulum. If, for instance, any such attempt were made with Bessel's toises, the observations of the pendulum in connection with these bars, would have to be repeated most accurately in the manner in which they were carried out by Bessel in 1826. An alteration in the mode of conducting such observations might easily bring out differences of the same magnitude as those which we seek to determine.

So fundamental a regulation of the standard would, in the introduction of an universal metric measure, be worthy of the nineteenth century, and would also, in a scientific point of view, throw greater light upon the as yet unknown subject of the mutability of bodies in relation to the three dimensions of space, as well as their specific gravities.

To ascertain the original length of a metric standard is just as desirable as to maintain the once accepted unit of length unchanged. But, as there exists no undoubted means of preserving the immutability of a standard bar, nothing else would appear to remain but from time to time, say every ten years, to repeat the measurement of the base line and to determine any alteration of length in the standard bar during the period.

The establishment and maintenance of a common standard measure of length would render necessary a permanently organized European department, for the

Appendix X.—*continued.*

comparison of standard measures. Without such a department, sooner or later there would be similar error and uncertainty in the several metres, as is found already in the toises, and which will next be noticed.

By direction of the Italian Geodesical Commission for the measurement of a degree of the meridan passing through the centre of Europe, Professor Schiavoni compared together, in 1865, two of the toises which had been placed at the disposition of the Commission. The first had been constructed by the mechanician Spano in Naples, the other by Ertel in Munich. He found their difference at 13° Reaumur to be S—E=0·0229591 line. He learned that by a previous and careful determination Ertel's toise at 13° Reaumur was 0·0072741 line shorter than the toise of Peru. Hence he deduced the following lengths:—

Toise of Peru, P = 864·0000000 lines.
„ Ertel, E = 863·9927259 „
„ Spano, S = 864·0156850 „

In the autumn of 1865, Professor Schiapparelli brought Spano's toise to Berlin, in order that the Commission which had been appointed to carry out the necessary proceedings for the central European measurement of a degree, might as soon as possible compare this toise with Bessel's, and with the mètre. But the war of 1866 absorbed the whole attention of the central department of Government and hindered the Commission from proceeding with their work. By chance, however, another occasion occurred of comparing Spano's toise. The North American minister, Mr. Wright, requested me to procure a copy of Bessel's toise for his Government. I made use of this opportunity for comparing the Italian toise with Bessel's at the same time as the American copy. No direct comparison was, however, made; it was made with another copy of Bessel's toise, No. 10, which had been constructed in 1852, under my directions, and which at 13° R.=863·999011 lines of Bessel's toise, with a probable error of 0·000109 line. (Verbindungen der Preussischen und Russischen Dreiecksketten, Berlin, 1857). This copy is made of unhardened cast steel, whilst Bessel's toise is of soft iron, and it was constructed in order to save Bessel's toise from being exposed to lengthened transport and numerous comparisons. It was used at Pulkowa and at Southampton, and constitutes the intermediate link between the comparisons of standard measures made by Struve and Sir Henry James. The observations for determining the length of the North American and Italian toises were conducted according to the same method which had been developed by me, in connecting the Prussian and Russian triangulations, and a similar method was followed in relation to the same toises of zinc, which in 1852 had been used in constructing the copies of Bessel's toise. It was thus that the change which the zinc toise had experienced, both in length and rate of expansion, since 1852, became known; but unfortunately only under the supposition that No. 10 had, since 1852, altered neither its length at its standard temperature, nor its co-efficient of expansion. For the comparing apparatus is not adapted to determine the absolute expansion.

The result was as follows:—

Length of the zinc bar at 0° - 1852 = 863·764143 lines.
„ „ - - - 1866 = 863·737397 „
„ „ at 13° R. - 1852 = 864·125902 „
„ „ „ - 1866 = 864·086527 „
Co-efficient of expansion of the zinc bar - - - - 1852 = 0·000025773 „
Co-efficient of expansion of the zinc bar - - - - 1866 = 0·000024874 „
The zinc bar was of the same length as the copy No. 10,
In 1852 at 6·59050° R.
„ 1866 at 9·16746° R.

As for the length of these two toises in lines of the toise of Peru, of which Bessel's toise contains 863·9992 lines, according to its certificate, (Bessel's Untersuchungen über die Länge des einfachen Secundenpendels, Berlin, 1828,) I found that Herr Baumann's North American toise made of English cast steel, at 13° R. =863·997938 lines, with a probable error of ·000255 line and Spano's toise, also at 13° R.=863·961885 lines. Hence it may be computed that Ertel's toise =863 ·938926 lines of the toise of Peru.

If these figures be compared with those shown above according to Schiavoni's deductions, and B be made to signify 864 lines of Bessel's toise corresponding with the toise of Peru, it will be found that the previous computation must be lessened by 0·053800 line, and we obtain,—

P. — B = 0·053800 line.
Ertel — B = 0·061074 „
Spano — B = 0·038115 „

As P as well as B *represents the true toise of Peru, their difference should be nil, or at least closely approaching it. It is thus, however, shown to be more* than half a tenth of a line.

Comparisons of various toises with Bessel's were first made in 1835, by Bessel himself, when he compared with his own toise two from Schumacher's collection, one made by Fortin, in 1821, the other by Gambey in 1831. (Darstellung der Untersuchungen und Maassregeln, welche durch die Einheit des Preussischen Längenmaasses veranlasst worden sind, von F. H. Bessel, Berlin, 1828.)

W. Struve afterwards compared in 1853 Bessel's toise with his own (the Dorpat toise), by means of the copy No. 10 before referred to. (Arc du Méridien entre le Danube et la mer glaciale, par W. Struve, St. Petersburg, 1860, Introd. p. lxxiii.)

Lastly, by means of the same copy No. 10, which meanwhile had been used by Sir Henry James in the comparison of standards at Southampton, the before-mentioned comparison with Spano's toise was made by me late in the autumn of 1866. The following tabular abstract gives a summary of all the known comparisons made with Bessel's toise, in which table, B=864 lines of the toise of Peru, of which Bessel's toise contains 863·9992.

No.	Description of Bar, Year of Construction, and by whom constructed.	T—B.	By whom and when comparison made.
		l.	
1	Bessel's toise, made by Fortin in 1823	—0·00080	Bessel, 1835.
2	Schumacher's toise, made by Fortin in 1821	+0·00253	
3	Do. do. Gambey in 1831	—0·00491	
4	Copy No. 10 of Bessel's toise, made by Baumann in 1852	—0·00099	Baeyer, 1852.
5	Belgian copy No. 11 of Bessel's toise, made by Baumann in 1852	—0·00110	
6	Russian toise, made by Fortin in 1821	—0·00013	W. Struve, 1853.
7	Italian computation of the toise of Peru, P	—0·05380	Schiavoni, 1865.
8	Do. do. Ertel, E	—0·06107	
9	Do. do. Spano, S	—0·03812	Baeyer, 1866.

Remark 1. Nos. 4 and 5 are exact copies of Bessel's toise. They are understood to agree with Bessel's toise in its stated length. So far as respects any change in the length of Bessel's toise since their construction they afford no means of information.

2. The small difference of No. 6 seems to be the result of a fortunate accident, to which it may be owing that the Prussian and the Russian toises can be looked upon as identical.

3. Nos. 2, 3, 7, 8, and 9 show, on the other hand, differences between themselves so far exceeding the limits of errors of observation that they cannot be explained otherwise than by a change in length of the bars; and as only one out of the five has a + sign prefixed to its assigned relative length, the general result appears to indicate a shortening of the bars in the course of time.

There can, indeed, hardly be a doubt that the various standard mètres would show similar differences in length, and that it will be requisite to reduce measurements made with mètres differing in length to one common standard, if there is really to be but one single unit of length. Advantage, therefore, can only be gained for scientific measurements by the general acceptance of a metric standard, if care be taken by regulations, from time to time to maintain the mètre of the several countries in precise and certain agreement with the original unit of length.

APPENDIX XI.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—ACCOUNT of the VERIFICATION at PARIS of METRIC STANDARDS of LENGTH, WEIGHT, and CAPACITY for the STANDARDS DEPARTMENT, presented by the French Government.

CONTENTS.

Page
Metric Standards for the Standards Department to be verified at Paris - - - - - - 159
Description of these Metric Standards - - - „
Comparisons made in 1869 - - - - - „
Verification of brass metre à bouts, 𝔐𝔅 - - - „
Comparisons of brass metre à traits, 𝔐𝔗 - - - 160
Verification of gilt brass kilogram, 𝔎𝔅 - - - „
Verification of another gilt brass kilogram, 𝔎𝔅¹, subsequently injured - - - - - - - 164
Verification of brass litre, 𝔏𝔅 - - - - 164
Verification in 1870 of gilt brass cylindrical kilogram 𝔎𝔆 - 167
Postscript by the Warden of the Standards - - 168
  French mode of noting weighings of kilograms - „
  Comparison of 𝔎𝔅 with Exchequer gilt gun metal kilogram 𝔎 - - - - - - 169
  Determination of density of 𝔎𝔅 - - - - „
  Comparison of 𝔎𝔅 with Exchequer platinum kilogram 𝔈 - - - - - - - - „

Account of the Verification of Metric Standards for the British Government.

etric andards r the Stanards Deartment to e verified t Paris.

The British Standards Commission having recommended in their Second Report that, with a view to the introduction and use of metric weights and measures in the United Kingdom, metric standards accurately verified in relation to the primary metric standards at Paris should be deposited in the Standards Department, a request to be furnished with such standards was made to the French Government by the British Foreign Minister, through Her Majesty's Ambassador at Paris. In his reply to Lord Lyons, dated 2nd September 1869, the Prince de la Tour d'Auvergne, the French Foreign Minister, stated that the French Government had given the necessary directions for acceding to the request of the British Government.

The Minister of Agriculture and Commerce accordingly directed General Morin, the Directeur du Conservatoire Impérial des Arts et Métiers, to provide such metric standards accurately verified; and in order to carry out all the operations of verification with the highest degree of precision, and to certify the results, Mr. Chisholm, the Warden of the Standards at London, proceeded to Paris on 14th October 1869 for the purpose of taking part with M. Tresca, the Sous Directeur du Conservatoire Impérial des Arts et Métiers, at his invitation, in all the operations of verification.

)escription f these netric tandards.

The metric standards to be provided for the Standards Department in London were as follows :—

1. A brass mètre à bouts (𝔐𝔅).
2. A brass mètre à traits (𝔐𝔗).
3. A gilt brass kilogram with knob (𝔎𝔅).
4. A gilt brass cylindrical kilogram (𝔎𝔆).
5. A brass litre (𝔏𝔅).

)omparions made n 1869.

Many comparisons of these standards were made by M. Tresca and Mr. Chisholm at the Conservatoire des Arts et Métiers, on the successive days from 15th October to 1st November 1869, inclusive, the several observations being taken and the results agreed upon by both officers. On 2nd November Mr. Chisholm returned to London, taking with him the kilogram 𝔎𝔅 and the litre 𝔏𝔅, their verification having been completed. Some further comparisons of the other three standards being requisite, they were left at the Conservatoire des Arts et Métiers, under the charge of M. Tresca, until all the comparisons should be completed previously to the three standards being forwarded to the Standards Department in London, when a detailed account of all the operations for each standard separately, showing the results of the several verifications, might be drawn up and vouched by the two verifying officers.

Verification of the Brass Mètre à bouts, 𝔐𝔅.

Verification of the brass mètre à bouts, 𝔐𝔅.

The brass standard mètre, 𝔐𝔅, was compared with the platinum mètre du Conservatoire (P^1), which had been determined in 1864 to be 0·00329 mm. longer than the mètre des Archives, its true length being 1·00000329 mètre.

The comparisons were made by means of a comparateur constructed by M. Brunner and designed by M. Silbermann. It consists of a platinum plane resting on a brass plane, thus forming a Borda thermometer, with two contact levers and microscopes.

15th October 1869, 4 p.m.—𝔐𝔅 and P^1 were placed in the trough of the comparateur and covered with ice, previously to which the two centigrade thermometers were at 16° and Borda's metallic thermometer at 130·30 div.

16th October 1869, 8 a.m.—𝔐𝔅 was placed in position for its length to be ascertained, and fresh ice was added. When sufficient time had elapsed for the temperature of the metal to be reduced to 0° C., or that of melting ice, the following readings were taken, after some observations had been made for testing the stability of the instruments :—

One div. of the micrometer=0·001 mm.

Readings of Micrometer.		Readings of Thermometers.		
		Borda.	Centigrade.	
	Div.	Div.	°	°
9.49 a.m. First observation of 𝔐𝔅 -	120·8 120·3 120·3 120·5	105·24 105·24 105·24 105·24	0·2 0·2 0·2 0·2	0·45 0·45 0·45 0·45
10 a.m. „ „ Mean -	120·475	105·24 (or + 0°·482)	0·2	0·45
10.10 a.m. First observation of P^1 - - -	162·70 163·10 162·95 162·85	104·46 104·46 104·46 104·48	0·2 0·2 0·2 0·2	0·4 0·4 0·4 0·4
11.40 a.m. „ „ Mean -	162·90	104·465 (or + 0·003)	0·2	0·4
1.40 p.m. Second observation of 𝔐𝔅 -	124·50 122·40 124·80 123·65	104·48 104·48 104·48 104·48	0·2 0·2 0·2 0·2	0.4 0·4 0·4 0·4
2 p.m. „ „ Mean -	123·837	104·48 (or +0·012)	0·2	0·4

These observations were completed at 2.30 p.m.

Appendix XI.—*continued.*

As the temperature during the second observation of 𝔐𝔅 agreed so nearly with that of the observation of P^1, it was determined to rest the comparison of 𝔐𝔅 on these two observations. But a second observation of P^1 was taken to test the accuracy of the first observation.

Readings of Micrometer.		Readings of Thermometers.		
		Borda.	Centigrade.	
	Div.	Div.	°	°
Second observation of P^1 - - -	163·25	104·80	0·2	0·3
	162·15	104·80	0·2	0·3
	162·10	104·80	0·2	0·3
Mean - - -	162·50	104·80 (or + 0·210°)	0·2	0·3

The mean reading of Borda's thermometer at the temperature of melting ice, or 0° C., was 104·4725 div.

		div.
Borda's thermometer at 16° C. being		130·3000
and at 0°	„	104·4725
it follows that 16° C.	=	25·8275

$$\text{Whence 1 div.} = \frac{16^\circ\text{ C.,}}{25\cdot8275}, \text{ or } 0\overset{\circ}{\cdot}62\text{ C.}$$

Result :—

$$\mathfrak{MB} - \overset{\text{d.}}{123\cdot837} = P^1 - \overset{\text{d.}}{162\cdot900} \qquad \text{mm.}$$

$$\text{Whence } \mathfrak{MB} = P^1 - 39\cdot063 \text{ or} - 0\cdot03906$$

$$P^1 = \text{Mètre des Archives} + 0\cdot00329$$

$$\therefore \mathfrak{MB} = \text{Mètre des Archives} - 0\cdot036$$

$$\text{or } 0\cdot999964\text{ m.}$$

The coefficient of linear expansion of the brass bar 𝔐𝔅 had been previously determined by Gambey to be 0·000019129 for 1° C.

Comparisons of Brass Standard Metre à Traits, 𝔐𝔗.

Comparisons of brass mètre à traits, 𝔐𝔗.

A series of observations was also made in October 1869 of a brass mètre à traits, by means of the comparateur constructed by M. Dumoulin-Froment for the Conservatoire des Arts et Métiers, for comparing mètres à bouts and à traits. But in consequence of some discordances which were afterwards found, caused by the relative positions upon the comparateur of the two mètres under comparison, the definitive verification of the brass mètre à traits, 𝔐𝔗, was deferred until a future period.

Verification of the Gilt Brass Kilogram, 𝔎𝔅.

Verification of gilt brass kilogram, 𝔎𝔅.

The new balance constructed by M. Deleuil, working in an iron case having circular openings to be closed with glass discs, from which the air can be exhausted by means of an air pump, having been completed and set up in proper order for use at the Conservatoire des Arts et Métiers, the comparisons of 𝔎𝔅 were begun with this new vacuum balance.

The first weighings of 𝔎𝔅 were made in air, against the gilt brass kilogram D No. 1, the side openings of the balance being closed merely with their cork stoppers, so that the working of the new balance, as well as its stability and sensibility, might be tested.

The volume of 𝔎𝔅 was considered to be identical with that of D No. 1, being 124 cc, or $\Delta = 8\cdot0645$.

The weighings were made by Borda's method of counterpoise, the counterpoise being always placed in the left-hand scale. The gilt brass kilogram D No. 8 + 5 mgr. was used as counterpoise (T).

—	Readings in Divisions.		Mean Difference.
27th Oct. 1869.	T ≏	D No. 1.	Div.
(1.) 8.25 a.m.	−0·5	+3·5	
	−0·5	+3·5	
	−0·5	+3·3	
	−0·4	+2·8	+1·40
(2.) 8.35 a.m.	−1·2	+5·5	
	−0·9	+5·0	
	−0·6	+4·7	
	−0·3	+4·3	+2·06

—	Readings in Divisions.		Mean Difference.
			Div.
27th Oct. 1869.	T ≏	D No. 1 + 2 mgr.	
(3.) 8.45 a.m.	−4·3	+2·0	
	−4·0	+1·5	
	−3·8	+1·1	
	−3·6	+0·8	−1·29
(4.) 9.0 a.m.	T ≏	D No. 1 + 0 mgr.	
	−0·0	+4·0	
	−0·0	+3·7	
	−0·0	+3·3	
	−0·0	+3·0	+1·75
(5.) 9.10 a.m.	−0·1	+3·2	
	−0·0	+3·1	
	+0·1	+2·8	
	+0·1	+2·6	+1·475
(6.) 9.30 a.m.	T ≏	D No. 1 + 1 mgr.	
	−0·6	+1·5	
	−0·8	+1·2	
	−0·8	+1·0	
	−0·8	+0·8	+0·19
(7.) 9.45 a.m.	T ≏	𝔎𝔅 + 0 mgr.	
	+0·6	+2·0	
	+0·6	+1·8	
	+0·6	+1·6	
	+0·6	+1·6	+1·175
(8.) 10.0 a.m.	T ≏	𝔎𝔅 + 1 mgr.	
	−0·9	+0·8	
	−0·9	+0·6	
	−0·9	+0·4	
	−0·9	+0·2	−0·20
(9.) 10.45 a.m.	T ≏	𝔎𝔅 + 0 mgr.	
	−0·3	+2·8	
	−0·2	+2·7	
	−0·2	+2·4	
	−0·2	+2·2	+1·15

To find the value of 1 div. of the index :—

From (1) (2) mean difference		+1·73 div.
(3)	„	−1·29
		mgr. div.
Whence 2 mgr.		=3·02, or 1=1·51
(4) (5) mean difference		+1·61
(6)	„	+0·19, or 1=1·42
(7) (9)	„	+1·16
(10)	„	−0·20, or 1=1·36
		div. mgr.
		Mean 1=1·43, or 1=0·70

Appendix XI.—*continued.*

Result of weighings:—

div.
Mean of (1) (2) (4) (5) T ≏ D No. 1+1·67
(7) (9) T ≏ 𝔎𝔅 +1·16 mgr.)
∴ 𝔎𝔅 = D No. 1+0·51 (or 0·36

Further weighings in air, with the same counterpoise:—

—	Readings in Divisions.		Mean Difference.
(1.) 11.45 a.m.	T	≏ D No. 1 + 100·5 mgr.	Div.
	−0·4	+0·6	
	−0·4	+0·4	
	−0·4	+0·2	
	−0·4	+0·1	
			−0·04
(2.) 12.30 p.m.	T	≏ C^1 No. 1 + 11 mgr.	
	−0·3	+3·0	
	−0·1	+2·8	
	−0·0	+2·6	
	+0·1	+2·5	
			+1·325
(3.)	T	≏ C^1 No. 1 + 12 mgr.	
	−2·6	+1·1	
	−2·2	+0·9	
	−2·1	+0·8	
	−2·0	+0·7	
			−0·675

From (2) (3) 1 mgr. = 2·0 div., or 1 div. = 0·50 mgr.
Result of weighings in air, b=754·70 mm., at t=13·0°.
t=17·80°.

Note.—The barometer being in an adjoining and less heated room.

mgr. div. mgr. div.
From (1) (3) D No. 1≏C^1 No. 1+12−0·675−100·5+0·04,
mgr. div. mgr.
or D No. 1≏C^1 No. 1−88·5−0·635 (or 0·32)
Whence D No. 1=C^1 No. 1−88·82

mgr.
Weight of air displaced by D No. 1=148·62
" by C^1 No. 1= 58·32

Excess by D No. 1= 90·30

mgr.
∴ in a vacuum D No. 1=C^1 No. 1+1·48
From previous weighings 𝔎𝔅 =D No. 1+0·36

Whence 𝔎𝔅 =C^1 No. 1+1·84

A direct comparison of 𝔎𝔅 with C^1 No. 1 was then made in a vacuum, so far as it could be obtained in the new vacuum balance by means of two air pumps.

T=counterpoise of D No. 8+5 mgr. as before.
b=754·79 mm., t. in balance case=18·0°.
h=atmospheric pressure in balance case.

—	Readings in Divisions.		Mean Difference.
(1.) 3.30 p.m. h=26·25 mm.	T	≏ 𝔎𝔅 + 1 mgr.	Div.
	−3·5	−1·8	
	−3·6	−2·0	
	−3·6	−2·2	
			−2·78
(2.) 3.50 p.m.	−4·3	−2·1	
	−4·3	−2·4	
	−4·3	−2·7	
			−3·35
(3.) 4.25 p.m.	T	≏ C^1 No. 1 + 3 mgr.	
	−4·4	−2·8	
	−4·7	−3·2	
	−4·9	−3·6	
			−3·93
(4.) 4.45 p.m. h=19·70 mm.	−3·8	−1·0	
	−4·0	−1·6	
	−4·3	−3·0	
	−4·8	−3·6	
			−3·26

Result:—

mgr. div. mgr. div.
From (2) (4) 𝔎𝔅≏C^1 No. 1+3−3·26−1+3·35.
mgr. div. mgr. div. mgr.
or 𝔎𝔅≏C^1 No. 1+2+0·09 (or 0·05 as 1=0·60)
Whence 𝔎𝔅=C^1 No. 1+2·05 mgr.

In air, mean h=22·97 mm., t=18·0°.

mgr.
Weight of air displaced by 𝔎𝔅=4·56
" C^1 No. 1=1·78

Excess by 𝔎𝔅 2·78

∴ In a vacuum 𝔎𝔅=C^1 No. 1+4·83 mgr.

28th October.—Some further comparisons of 𝔎𝔅 with C^1 No. 1 were next made, by weighing each standard weight in an exhausted receiver, Deleuil's balance No. 6 being used.

On the previous day, the two kilograms and following adjuncts had been placed in the balance case:—

A small rectangular plate of ground glass, on which were placed two small circular discs of ground glass to support the kilograms. These two discs were fixed in their places by a little tallow, and around them some more tallow was thinly spread, upon which the receiver was to be placed.

A small receiver of glass, with a brass rim at the bottom, and a brass covering fitted with a stop-cock.

An approximate counterpoise (T), consisting of the gilt brass cylindrical kilogram No. 2, with similar adjuncts and the requisite counterpoise weights.

The method of comparison was as follows:—

𝔎𝔅 was first placed upon one of the glass discs and covered with the receiver, and the air having been exhausted by an air pump, they were placed in the right-hand scale, together with the additional weights required to replace the weight of the air discharged, and to establish an approximate equilibrum to the counterpoise T.

After the weighings of 𝔎𝔅, it was removed from under the receiver and from its glass disc, and C^1 No. 1 being placed upon the second disc, a similar course was followed; great care being taken that no portion of the tallow was lost.

—	Readings in Divisions.		Mean Difference.
(1.) 8.45 a.m.	T	≏ 𝔎𝔅 in vacuo, &c. + 185 mgr.	Div.
	−2·0	−0·3	
	−1·9	−0·2	
	−1·9	−0·5	
			−1·13
(2.) 9.25 a.m.	T	≏ C^1 No. 1, &c. + 191 mgr.	
	−1·2	+4·6	
	−1·2	+4·4	
			+1·165
(3.) 9.45 a.m.	T	≏ C^1 No. 1, &c. + 193 mgr.	
	−2·8	+3·1	
	−2·6	+3·0	
	−2·5	+2·9	
			+0·18

From (2) (3) 2 mgr.=1·47 div., whence 1 div. = 1·35 mgr.

Result:—

mgr. div. mgr. div.
From (1) (3) 𝔎𝔅 ≏ C^1 No. 1+193+0·18−185+1·13
or 𝔎𝔅 ≏ C^1 No. 1+ 8+1·31 (or 1·77 mgr.)
∴ In a vacuum 𝔎𝔅 = C^1 No. 1+9·77 mgr.

Further weighings of C^1 No. 1 in air, with the same adjuncts and counterpoise:—

In air b = 757·05 mm., t = 14·8°.

—	Readings in Divisions.		Mean Difference.
(4.) 10.0 a.m.	T	≏ C^1 No. 1 + 0 mgr.	Div.
	−1·4	+1·2	
	−1·1	+0·9	
	−1·1	+0·8	
			−0·12

The weight of air of the stated pressure and temperature, contained in the receiver, exclusive of the volume of C^1 No. 1, was thus shown to be 193 mgr.

Appendix XI.—*continued.*

A second set of observations was then taken of the two kilograms in an exhausted receiver, a similar counterpoise being used.

—	Readings in Divisions.		Mean Difference.
(5.) 10.20 a.m.	T ≏	C¹ No. 1 in vacuo, &c. +281 mgr.	Div.
	−2·4	+5·0	
	−2·1	+4·7	
	−2·0	+4·3	+1·25
(6.) 10.30 a.m.	T ≏	C¹ No. 1, &c. +283 mgr.	
	−2·1	+1·8	
	−2·0	+1·8	
	−2·0	+1·8	−0·12

—	Readings in Divisions.		Mean Difference.
(7.) - -	T ≏	𝔎𝔅, &c. +271 mgr.	Div.
	−1·3	+0·3	
	−1·4	+0·0	
	−1·4	+0·0	−0·63

Here from (1) (2) 2 mgr. = 1·37 div., or 1 div. = 1·46 mgr.

From (2) (3) 𝔎𝔅 ≏ C¹ No. 1 + 283 mgr. − 0·12 div. − 271 mgr. + 0·63 div.
or 𝔎𝔅 ≏ C¹ No. 1 + 12 + 0·51 (or 0·77 mgr.)
∴ In a vacuum 𝔎𝔅 = C¹ No. 1 + 12·77 mgr.

In the afternoon of the same day, some additional comparisons were made in the vacuum balance, the air being exhausted.

The counterpoise T was the gilt brass kilogram D No. 8 + 5 mgr.

—	Pressure in Balance Case.	Readings in Divisions.		Mean Difference.
		T ≏	𝔎𝔅 + 1 mgr.	Div.
(1.) 4.15 p.m. -	h = 21·88 mm. -	+2·1	+6·5	
	24·68 -	+2·3	+5·1	
	26·18 -	+2·4	+5·7	
		+2·5	+5·5	
	Mean 24·25 mm.			+4·14
		T ≏	C¹ No. 1 + 1 mgr.	
(2.) 5.0 p.m. -	26·18 -	+4·8	+8·9	
	27·48 -	+4·7	+8·4	
	29·08 -	+4·6	+8·0	
	„ 27·58 -			+6·57
(3.) 5.5 p.m. -	29·08 -	+1·9	+8·2	
	— -	+1·9	+7·1	
	—	+1·9	+6·6	
	38·58 -	+1·9	+6·0	
	„ 33·83 -			+4·44
(4.) 5.11 p.m. -	67·38 -	−5·0	+1·5	
	69·88 -	−5·0	+0·4	
	72·18 -	−4·9	−0·2	
	„ 69·85 -			−2·20

t. in balance case = 17°·4
b. in adjoining room = 755·59 mm. at t 10°·9

To find the value of 1 div. of the balance, it was considered that it might be determined from the difference of the number of divisions as compared with the relative difference of air displaced by the two kilograms, thus avoiding the necessity of opening the balance case, in order to place an additional balance weight in the scale, and of again exhausting the air for the purpose of making a further observation.

From (2) (4). Increase of pressure of 42·27 mm. corresponds with 8·77 div.

b = 42·27 mm. t = 17°·4, Weight of air displaced by T = 8·54 mgr.
„ „ „ C¹ No. 1 = 3·30

Excess by T = 5·24

Whence 8·77 div. = 5·24 mgr.
or 1 „ = 0·60 „

Result of weighings:—

From (1) (2) 𝔎𝔅 ≏ C¹ No. 1 + 1 mgr. + 6·57 div. − 1 mgr. − 4·14 div.
or 𝔎𝔅 ≏ C¹ No. 1 + 2·43 „ (or 1·46 mgr.)
Whence 𝔎𝔅 = C¹ No. 1 + 1·46 mgr.

b = 24·25 mm., t = 17°·4, Weight of air displaced by 𝔎𝔅 = 4·85 mgr.
b = 27·58, t = 17·4, „ „ C¹ No. 1 = 2·14

Excess by 𝔎𝔅 = 2·71

∴ In a vacuum 𝔎𝔅 = C¹ No. 1 + 4·17 mgr.

Appendix XI.—*continued.*

29th October.—The observations with Deleuil's vacuum balance were continued at various pressures, the counterpoise T being D No. 8 + 6 mgr.

——	Pressure in Balance Case.	Readings in Divisions.		Mean Difference.
		T ≘	C¹ No. 1 + 0 mgr.	
(1.) 4.30 p.m. -		+3·7	+9·7	Div.
		+3·7	+8·8	
	h = 58·15 mm. -	+3·6	+8·0	
	65·54 -	+3·4	+7·4	
	68·48 -	+3·2	+7·0	
	—— Mean 64·06 mm.			+5·85
(2.) 4.48 p.m. -		−0·0	+3·9	
	81·61 -	−0·1	+3·2	
		−0·3	+2·6	
	—— „ 81·61 -			+1·55
		T ≘	𝔎𝔅 + 5 mgr.	
(3.) 5.11 p.m. -		−0·7	+1·8	
	17·31 -	−0·7	+1·4	
	21·96 -	−0·8	+1·2	
	—— „ 19·63 -			−0·37
(4.) 5.27 p.m. -	39·84 -	−1·0	+1·3	
	42·46 -	−1·0	+1·0	
	44·47 -	−1·0	+0·9	
	—— „ 42·46 -			+0·03
(5.) 5.54 p.m. -	— -	−1·0	+3·0	
	— -	−1·6	+1·5	
	— -	−1·0	+1·5	
	—— „ 72·42 -			+0·50
(6.) 6.7 p.m. - -	— -	−0·4	+1·9	
	— -	−0·4	+1·8	
	— -	−0·4	+1·5	
	—— „ 88·08 -			+0·67

(1) *t* in balance case = 17°·0 *b* = 766·17 mm. at 12°·0
(5) *t* „ = 17·2 *b* = 766·90 „ 12·6

To find value of 1 division of balance:—

From (1) (2). Increase of pressure 17°·55 corresponds with 4·30 div.

mm. mgr.
h=17·55, *t*=17, Weight of air displaced by T=4·17
„ „ „ by C¹ No. 1=1·37

Excess by T=2·80

div. mgr.
Whence 4·30=2·80
or 1 =0·65

Result of weighings:—

From (2) (5) 𝔎𝔅=C¹ No. 1+1·55 div.—5 mgr.—0·50
or 𝔎𝔅=C¹ No. 1—5 mgr.+1·05 div. (or 0·68 mgr.)
Whence 𝔎𝔅=C¹ No. 1—4·32 mgr.

mm. mgr.
h=72·42 at 12°·6, *t*=17°·2, Weight of air displaced by T=14·40
h=81·61 at 12·0, *t*=17·0, „ „ C¹ No. 1= 6·37

Excess by T = 8·03

∴ In a vacuum 𝔎𝔅=C¹ No. 1+3·71 mgr.

1st November.—The last comparisons of 𝔎𝔅 with C¹ No. 1 were made in ordinary air, with Deleuil's vacuum balance. The counterpoise T was D No. 8+100 mgr.

3.10 p.m. *t* in balance case=16°·8
b in adjoining room (1) 769·08 mm. at 12°·9
(2) 769·38 „ 12·9

——	Readings in Divisions.		Mean Difference.
(1.) - -	T ≘	𝔎𝔅 + 103 mgr.	Div.
	−2·2	+0·2	
	−2·2	+0·1	
	−2·3	−0·3	
			−1·11
(2.) - -	T ≘	C¹ No. 1 + 13 mgr.	
	−1·3	−0·2	
	−1·3	−0·4	
	−1·3	−0·7	
			−0·87

——	Readings in Divisions.		Mean Difference.
(3.) - -	−2·2	+0·2	Div.
	−2·2	−0·2	
	−2·2	−0·3	
			−1·15
(4.) - -	T ≘	C¹ No. 1 + 12 mgr.	
	−0·0	+1·4	
	−0·0	+1·2	
	−0·0	+1·0	
			+0·60

Appendix XI.—*continued.*

From (3) (4) 1 mgr.=1·75 div., or 1 div.=0·57 mgr.
From (1) (2) (3) 𝕶𝕭=C^1 No. 1+13 mgr.—1·01 div.—103 mgr.+1·11 div.
or 𝕶𝕭=C^1 No. 1—90 mgr.+0·10 div. (or 0·06 mgr.)
Whence 𝕶𝕭=C^1 No. 1—89·94 mgr.

mgr.
Weight of air displaced by 𝕶𝕭=152·14
„ „ C^1 No. 1= 59·69

Excess by 𝕶𝕭= 92·45

∴ In a vacuum 𝕶𝕭=C^1 No. 1+2·51 mgr.

Summary of Comparisons of 𝕶𝕭.

Direct comparisons with C^1 No. 1:—

In Deleuil's vacuum balance, weighings in rarefied air:—

mgr.
27th October, =C^1 No. 1+4·83
28th „ 𝕶𝕭=C^1 No. 1+4·17
29th „ 𝕶𝕭=C^1 No. 1+3·71
Mean ——+4·24 mgr.

In Deleuil's balance, weighings in ordinary air:—

mgr.
27th October, by comparison with D No. 1, 𝕶𝕭=C^1 No. 1+1·84
1st November, „ 𝕶𝕭=C^1 No. 1+2·51
Mean ——+2·18 mgr.

mgr.
Mean result of all the weighings in air, 𝕶𝕭=C^1 No. 1+3·41
As C^1 No. 1=Kilog. des Archives+0·72

∴ 𝕶𝕭=Kilog. des Archives+4·13, or=1·00000413 k.

Weighings in exhausted receiver:—

mgr.
28th October, 𝕶𝕭=C^1 No. 1+ 9·77
„ 𝕶𝕭=C^1 No. 1+12·77
Mean ——+11·27 mgr.

Less mean weight of 𝕶𝕭 in exhausted receiver 7·86

A similar difference in the results of the weighings in air, and in an exhausted receiver, was found on comparing the gilt brass kilogram D No. 1 with C^1 No. 1.

mgr.
By a previous comparison in air on 22nd October, D No. 1=C^1 No. 1+ 3·29
Similar comparison in air on 27th October D No. 1=C^1 No. 1+ 1·48
∴ D No. 1=C^1 No. 1 + 2·39
By comparison in exhausted receiver, on 22nd Oct. D No. 1=C^1 No. 1 +11·90

Less mean weight of D No. 1, in exhausted receiver 9·51

In all these weighings in an exhausted receiver, the exhaustion with the air pump was continued until the mercurial gauge showed a pressure of less than 5 mm.

As the weight of 𝕶𝕭, derived directly from C^1 No. 1 by weighings in air, agreed so nearly with its weight derived from C^1 No. 1 through D No. 1, it was considered satisfactory, and it was consequently determined that 𝕶𝕭=1·00000413 k.

Verification of another Gilt Brass Kilogram, 𝕶𝕭^1, subsequently injured.

Verification of another gilt brass kilogram, 𝕶𝕭^1, subsequently injured.

In October 1869 a second gilt brass kilogram with a knob, 𝕶𝕭^1, intended for the British Government, was accurately verified at the Conservatoire Impérial des Arts et Métiers by M. Tresca and Mr. Chisholm; but unfortunately, after the comparisons had been completed and when its density was being determined by the stereometer, this kilogram was accidentally damaged by mercury. It may however be desirable to state the final results of the comparisons of 𝕶𝕭^1, for the purpose of showing that similar discordances of the weighings in air and in an exhausted receiver, such as have been already mentioned in the comparisons of , were also found in the comparisons of 𝕶𝕭^1.

The mean results of the weight of 𝕶𝕭^1 were as follows:—

mgr.
From weighings in air 𝕶𝕭^1 = C^1 No. 1 + 3·29
„ in an exhausted receiver 𝕶𝕭^2 = C^1 No. 1 + 11·90

∴ 𝕶𝕭^1 lighter from weighings in an exhausted receiver — 8·61

In consequence of the damage sustained by 𝕶𝕭^1, it was considered desirable to replace this kilogram by another gilt brass kilogram, the verification of which will subsequently be described.

Verification of the Standard Litre, 𝕷𝕭.

18th October 1869.—The standard brass litre 𝕷𝕭 was verified by weighing its contents of distilled water against a gilt brass kilogram D No. 1, in Deleuil's balance.

A counterpoise T was made with a gilt brass kilogram and a brass litre and its disc.

Appendix XI.—*continued.*

The first comparison was as follows:—

—		Readings in Divisions.		Mean Difference.
		T ≏	𝕷𝕭 & disc + D No. 1.	Div.
mm. $b = 757 \cdot 20$ at t 16°·5		d.	d.	
Correction to 0° = −2·01	(1.)	−0·9	+0·40	
		−0·9	+0·35	
$h = 755 \cdot 19$		−0·9	+0·35	−0·26
Mean *t.* of water 16°.		T ≏	𝕷𝕭 & disc + D No. 1 + 2 mgr.	
	(2.)	−1·5	−0·4	
		−1·4	−0·5	−0·95
		T ≏	𝕷𝕭 full of water, with disc + 1·257 grm.	
	(3.)	−1·0	+1·1	
		−0·9	+1·0	
		−0·9	+1·0	+0·05
		T ≏	𝕷𝕭 full of water, with disc + 1·258 grm.	
	(4.)	−0·30	+1·1	
		−0·25	+1·1	+0·41

The correction (*c*) of a litre for the temperature of the water, the loss of weight in air, the moisture of the air, and the expansion of the vessels, has been taken from the following table, which was prepared by M. Tresca and used in 1868 for the reverification of the local metric standards of capacity:—

Table of corrections for the loss of weight of a litre of distilled water, contained in a brass standard measure, and weighed against brass weights in air, at 72° of Saussare's hygrometer, the barometer being at 760 mm. at 0° C.; the coefficient of linear expansion of brass for 1° C. being taken at 0·00001875.

t.	Gramme.	t.	Gramme.
0° C.	1·264	13° C.	0·952
1 „	1·152	14 „	1·026
2 „	1·055	15 „	1·112
3 „	0·972	16 „	1·210
4 „	0·903	17 „	1·320
5 „	0·850	18 „	1·442
6 „	0·811	19 „	1·576
7 „	0·796	20 „	1·722
8 „	0·776	21 „	1·880
9 „	0·791	22 „	2·050
10 „	0·802	23 „	2·232
11 „	0·840	24 „	2·426
12 „	0·890	25 „	2·632

This table is considered to be a more accurate computation than that previously used, which had been drawn up under the directions of the French Government by M. Coriolis, Member of the Institute, and a copy of which is contained in the Appendix to the Second Report of the Standards Commission of 1869, p. 38.

According to M. Tresca's tables, the correction of a litre at a pressure of 760 mm., and temperature of the water 16° C., should be 1·210 grm., but 1·257 grm. were found requisite to obtain an approximate equipoise of 𝕷𝕭, &c. with *x*.

These weighings of 𝕷𝕭, &c. were taken between 10.30 a.m. and 11.55, and several more were taken until 1 p.m., when the barometer had fallen to 755·00 mm., at 16·5°, and the mean resting point of 𝕷𝕭 was +2·3 d. It was thus seen that the scale containing 𝕷𝕭 filled with water was getting gradually lighter, and considerably more so than was due to the fall of the barometer; whence it was inferred that there was a slight evaporation of the water, notwithstanding its being covered with the discs, which had no small hole in the middle, as the discs have which are used in the Standards Department at London. The result was consequently determined from the first weighing only of 𝕷𝕭 as follows:—

For value of 1 div. From (1) (2) 2 mgr. = 0·683 div.
or 1 = 0·341
From (3) (4) 1 = 0·36

Mean 1 = 0·35 or 1 div. = 2·85 mgr.

Air $b = 755 \cdot 19$ mm., $t = 16°$.
Correction $(c) = -1 \cdot 202$ grm.

From (1) (3) Weight of water 𝕷𝕭 − *c* + 1·257 grm. + 0·05 div. ≏ D No. 1 − 0·26 div.
Whence weight of water in 𝕷𝕭 = D No. 1 − 0·055 grm. − 0·316 div. (or 0·9 mgr.)
∴ Weight of water in 𝕷𝕭 = D No. 1 − 0·054

18th October, 1.40 p.m.—The weighings of 𝕷𝕭 were continued, 1·274 grm. being found requisite to obtain an equipoise of the balance.

From 1.40 p.m. ($b = 754 \cdot 45$ mm., at 16°·3) the resting point of 𝕷𝕭, &c. = + 0·5 div.
to 2.37 p.m. ($b = 754 \cdot 08$, at 16·3) „ „ = + 4·05 „ ,

thirty-five different weighings were taken, showing a continued progressive loss of weight in the scale containing 𝕷𝕭 filled with water, attributable to evaporation, and amounting altogether to 3·45 div. or 9·83 mgr.

Appendix XI.—*continued.*

Under these circumstances the following comparisons were made :—

——	Readings in Divisions.		Mean Difference.
2.37 p.m. b=754·03 mm. at 16·3°. t. of water 16·25°.	T ≏	𝔏𝔅, &c. + 1·274 grm.	Div.
(5.) - -	+2·1	+6·0	
	+2·8	+6·0	+4·22
3.55 p.m. b=753·78 mm. at 16·5°. t. of water 16·25°.	T ≏	D No. 1, &c.	
(6.) - -	0·0	+2·1	
	+0·1	+1·9	
	−0·1	+1·9	+0·98

Mean pressure 753·90 mm. at 16°·4. Corrected to 0° = 751·90 mm.

t = 16·25°, b = 751·90 mm. Correction = 1·224 grm.

Result :—Weight of water in 𝔏𝔅 − c + 1·274 grm. + 4·22 div. ≏ D No. 1 + 0·98 div.
Whence weight of water in 𝔏𝔅 = D No. 1 − 0·050 grm. − 3·24 d. (or 9·2 mgr.)
∴ Weight of water in 𝔏𝔅 = D No. 1 − 0·059 grm.

19th October.—A different arrangement was made for the weighings of 𝔏𝔅, by using as a counterpoise a litre full of water, and placing a slight coating of tallow on the upper surface of the two brass litres as a preventive to evaporation.

10.27 a.m., b = 747·79 mm. at 15·8°, | T = unterpoise of a brass litre filled with water and disc.
t of water = 15·9°. | T ≏ co , filled with water and disc + 361 mgr.

Twenty-four weighings having been taken, the resting point of 𝔏𝔅, &c. was found to vary progressively from − 0·45 d. to + 0·85 d., when the following definite readings were taken :—

——	Readings in Divisions.		Mean Difference.	
	T ≏	𝔏𝔅 full of water, and disc + 361 mgr.	Div.	
(7.) -	+0·5	+1·3	+0·90	
11 a.m. b=748·05 mm. at 15°·9.	+0·6	+1·4	+1·00	
	+0·7	+1·4	+1·05	+0·98
	T + 1·000 grm. ≏	𝔏𝔅 empty and disc + D No. 1 + 0·170 grm.		
(8.) -	−2·8	+2·2	−0·30	
	−2·8	+2·0	−0·40	
	−2·8	+1·8	−0·50	−0·40

These weighings were continued with little variation of the barometrical pressure, seven more readings being taken, when the scale with the counterpoise of a litre filled with water became progressively lighter until the mean resting point was − 2·4 d., showing during the ten readings a loss from 0·3 d. to 2·4 d. or 2·1 d. = 3·82 mgr. It was therefore determined to rest the comparison upon the last reading of (7) and the first reading of (8).

The value of 1 division was determined as follows :—

(9.)	T ≏	𝔏𝔅 filled with water, &c. + 360 mgr.	
	−0·9	+1·8	
	−0·9	+1·8	+0·45 d.
(10.)	T ≏	𝔏𝔅 filled with water, &c. + 362 mgr.	
	−1·3	+0·0	
	−1·3	+0·0	−0·65

Whence 2 mgr. = 1·10
1 „ = 0·55 or 1 d. = 1·82 mgr.

Result :—
Mean b = 747·92 mm. at 15°·85
Corrected to 0° b = 746·00. t of water 15°·9
Whence c = −1·179 grm.

From (7) Weight of water in 𝔏𝔅 − c + 361 mgr. + 1·05 d. ≏ D No. 1 − 1·000 grm. + 0·170 grm. − 0·30 d.
Whence weight of water in 𝔏𝔅 = D No. 1 − 0·012 − 1·35 d. (2·46 mgr.)
∴ Weight of water in 𝔏𝔅 = D No. 1 − 0·014

From 1st comparison, weight of water in 𝔏𝔅 = D No. 1 − 0·054
„ 2nd „ „ 𝔏𝔅 = D No. 1 − 0·059

Mean of the three comparisons 𝔏𝔅 = D No. 1 − 0·042

Appendix XI.—*continued.*

31st October.—A last and definite comparison was made of 𝔏𝔅, which had been filled with distilled water at 5 p.m. on 30th October, and placed, together with the several weights, &c., in the balance case, in order that everything should be in readiness to complete the observations as rapidly as possible. A few drops of water were now added exactly to fill 𝔏𝔅.

——	Readings in Divisions.		Mean Difference.
			Div.
	T ≏ 𝔏𝔅 filled with water, with disc + 1·256 grm.		
9,40 a.m. b. = 769·80 mm. at 12°·5, t. of water = 12°·6. T = counterpoise of D No. 8, with litre empty and disc.	−4·4	+4·4	
	−4·4	+4·1	
	−4·2	+4·1	
	−4·3	+4·1	
			−0·075
	T ≏ 𝔏𝔅 empty, with disc + D No. 1 + 0·286 grm.		
10,15 a.m. b. = 769·50 mm. at 13°·1, t. of water = 12°·08 -	−0·2	+1·0	
	−0·1	+1·0	
	−0·1	+0·9	
	−0·1	+0·9	
			+0·412
	T ≏ 𝔏𝔅 empty, with disc + 0·287 mgr.		
10.20 a.m. - - - - - -	−1·9	+1·0	
	−1·9	+1·1	
	−1·9	+1·0	
d.			−0·433

∴ 1 mgr. = 0·845 or 1 div. = 1·18 mgr.

Result :—

Mean b = 769·65 mm. at 12°·8
Corrected to 0° = 766·96
∴ c = −0·940 grm.

Weight of water in 𝔏𝔅 − c + 1·256 grm. − 0·075 div. ≏ D No. 1 + 0·287 grm. − 0·433 div.
Whence weight of water in 𝔏𝔅 = D No. 1 − 0·029 − 0·358 (0·4 mgr.)

∴ Weight of water in 𝔏𝔅 = D No. 1 − 0·029

This result differs only 13 mgr. from the mean of the previous comparisons, and may be deemed conclusive.

As D No. 1 = 1·00000311 kilo. it follows that the weight of the contents of distilled water in 𝔏𝔅 at the maximum density differs from the Kilogramme des Archives only 0·02588 grm. in deficiency, being = 0·99997411 kilog.

Summary of Verification of Metric Standards.

Brass mètre à bouts 𝔐𝔅 - - - - - - -	=	0·999964 m.
Gilt brass kilogram with knob 𝔎𝔅 - - - - - -	=	1·00000413 k.
Brass litre 𝔏𝔅 contains weight of distilled water at its maximum density	=	0·99997411 k.

H. Tresca.
H. W. Chisholm.

Conservatoire Impérial des Arts et Métiers, Paris,
2nd November 1869.

Verification of the Gilt Brass Cylindrical Kilogram, 𝔎ℭ.

Verification of gilt brass cylindrical kilogram, 𝔎ℭ.

Subsequently to the comparisons in October 1869 of the Metric standards to be presented by the French Government to the British Government, it was agreed by M. Tresca and Mr. Chisholm that it would be desirable to substitute for the damaged gilt brass kilogram 𝔎𝔅^1, another gilt brass kilogram, cylindrical in form and of equal diameter and height, denoted as 𝔎ℭ.

The construction of such a gilt brass cylindrical kilogram, having neither cavity nor plug, had been recommended by M. Tresca, in the case of two kilograms required for the Government of Finland, the procuring of which had been entrusted in July 1870 to M. Lemström, Professor of Physics in the University of Helsingfors; and numerous experimental comparisons with very satisfactory results led to the conclusion that it was expedient to adopt this form of kilogram.

The verification of the kilogram 𝔎ℭ, which had been thus selected, was effected in August 1870, during the stay of Mr. Chisholm at Paris, with the assistance of M. Lemstrom.

The brass kilogram 𝔎ℭ, when delivered at the Conservatoire Impérial des Arts et Métiers by Messrs. Collot, was found on examination to be free from flaws on its surface, and to weigh 997 grammes. It was then gilt at the factory of Messrs. Christofle and Co., with 3·350 grammes of gold. After being turned on each surface, it was found to weigh 1000·000008 grm., and in this condition it was carefully measured.

It was finally adjusted at the Conservatoire by means of a lapidary's wheel, after its mean weight had been determined by numerous weighings in air.

The final comparisons were made by weighings in a vacuum, and the following is an account of the definitive operations for determining the volume and weight of this standard kilogram.

Determination of volume of 𝔎ℭ.

The volume of 𝔎ℭ was determined by means of a measuring apparatus constructed by Gambey for the purpose of ascertaining the volume of cylindrical kilograms, and which has a vernier showing a difference of 0·01 mm.

The height was measured at the axis, and at four corresponding points at the extremities of two diametrical lines at right angles to each other.

The diameter was measured at three different heights and at four several points of the circumference of the cylinder, 45° distant from each other.

Each measure was taken five times successively.

Mean of the five readings:

Of the first point of contact or collimation, at the beginning of the observations - -	mm. 34·36	
At the end - -	34·367	
		mm. mean 34·3635
Of the diameter:		
Near one end of the cylinder - -	1st, 87·680 2nd, 87·680 3rd, 87·677 4th, 87·682	
		„ 87·67975
At the middle of the cylinder - -	1st, 87·671 2nd, 87·670 3rd, 87·670 4th, 87·670	
		„ 87·67025

Appendix XI.—*continued.*

mm. mm.

Near the other end of the cylinder - - 1st, 87·680
2nd, 87·680
3rd, 87·681
4th, 87·680
mean 87·68025

Of the height - - 1st, 87·723
2nd, 87·720
3rd, 87·720
4th, 87·720
5th, 87·710
„ 87·7186

mm. m. mm.
Whence, H = 87·7186 − 34·3635 or 53·3551
D = 87·6768 − 34·3635 or 53·3133

The mean temperature during the observations was 22·3° C., but no reduction to 0° was requisite, as the comparing scale and the kilogram measured were made of similar metal. The volume of the kilogram was consequently found to be

V = 119·10736 cubic centimetres.

This volume was subsequently reduced by the removal of 8·68 mgr. of gold in the final adjustment of the weight of the kilogram, corresponding with a volume of 0·00045 cc. at the density of 19·258. The final determination of the volume of 𝔎ℭ was consequently

V = 119·10691
or Δ = 8·3958

Weighin of 𝔎ℭ.

All the weighings of 𝔎ℭ were made with M. Deleuil's vacuum balance. The comparisons being made with the platinum kilogramme du Conservatoire C¹ No. 1.

The air was exhausted from the balance case as far as possible. The pressure remaining (h) was computed each time by measuring, through the means of a cathetometer, the difference between the height of a barometrical column of mercury, and of a manometrical tube of mercury, the upper part of which was in communication with the balance case.

For a counterpoise, one of the Finland gilt brass kilograms F² was used, the volume of which had been determined, by a similar method to that already described, to be 119·06273 cc. (or Δ = 8·3989). This kilogram, with the additional weight of 3 mgr. placed in the left-hand pan of the balance, formed the counterpoise T.

——	No. of Comparison.	Pressure in Balance Case.	Readings in Divisions.			Mean Difference.
mm. mm. Bar. = 760·52 at 22°·56, or 757·41 at 0° d. Hygrom. Dry bulb 221·07 = 23°·38 C. Wet „ 201·70 = 17·17 Proportion of saturation = 0·523 mgr. Weight of air displaced by T - = 1·112 „ C¹ No. 1 = 0·455 Excess by T = 0·657	(1.)	mm. h. = 5·99 or at 0° = 5·97	T −1·0 −1·0 −1·0	≏	C¹ No. 1. +0·1 +0·0 +0·0	Div. −0·483
mgr. Weight of air displaced by T - = 3·387 „ C¹ No. 1 = 1·389 Excess by T = 1·998	(2.)	h. = 18·30 or at 0° = 18·23	−5·3 −5·3 −5·2		−3·2 −3·3 −3·4	−4·067
mm. mm. Bar. = 760·20 at 22°·93, or 757·41 at 0° d. Hygrom. Dry bulb 222·0 = 23°·65 Wet „ 203·7 = 17·67 Proportion of saturation = 0·542 mgr. Weight of air displaced by T = 0·882 „ 𝔎ℭ = 1·042 Excess by 𝔎ℭ = 0·160	(3.)	h. = 5·63 or at 0° = 5·61	T −1·3 −1·2 −1·1	≏	𝔎ℭ +2·2 +2·0 +1·8	+0·400
	(4.)	h. = 12·30	−1·9 −1·8 −1·5		+2·4 +2·2 +2·0	−0·233

Comparison No. (4) was taken merely to check the accuracy of the preceding comparison.

To find the value of 1 division :—

From (1) (2) 3·8 d. correspond with a difference of weight of air of 1·341 mgr.
Whence 1 div. = 0·352 mgr.

Results of weighings :—

From (1) (3) 𝔎ℭ + 400 d. (or 0·140 mgr.) — 0·160 mgr. = C¹ No. 1 — 0·483 d. (or 0·170 mgr.) + 0·657 mgr.
∴ In a vacuum 𝔎ℭ = C¹ No. 1 + 0·506 mgr.
mgr.
And as C¹ No. 1 = Kilogramme des Archives + 0·72
∴ 𝔎ℭ = „ „ + 1·226
or 𝔎ℭ = 1·000001226 k.

H. Tresca.
H. W. Chisholm.
S. Lemstrom.

Conservatoire Impérial des Arts et Métiers, Paris,
16th August 1870.
A. Morin, Director.

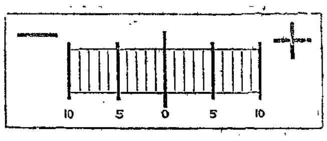
Postscript by the Warden of the Standards.

French mode of noting weighings of kilograms.

The mode of observing and noting the oscillations of the balance used in the comparisons of kilograms at the Conservatoire des Arts et Métiers differs from that employed in the Standards Department, in consequence of the index scale of the French balances being placed at the base of the pillar of the balance, and the index needle being vertical and pointing downwards from the middle of the beam to the graduated scale.

Appendix XI.—*continued.*

The scale, graduated on ivory, is of about the following size and form, the readings being noted as + or —.



In the readings, the tenths of a division are taken by estimation.

The weighings being made by Borda's method of counterpoise, and the counterpoise being placed in the left-hand scale, and the standard to be compared in the right-hand scale, the readings when + always show that the amount of the stated weight is to be added to the standard, and when — to be deducted.

Comparison of 𝔎𝔅 with Exchequer gilt gun-metal kilogram 𝔎.

It has been already stated that the result of the comparisons at Paris in 1869 of the gilt brass kilogram 𝔎𝔅 with the platinum kilogramme du Conservatoire, C[1] No. 1, has been to determine the weight of 𝔎𝔅 = 1·00000415 k. in relation to the kilogramme des Archives.

Since 𝔎𝔅 was deposited in the Standards Department, the following further comparison was made on 30th November 1869 with the gilt gun-metal Exchequer kilogram 𝔎, which had been determined to be = 1·00001034 k. of the kilogramme des Archives.

In air *t.* = 61°·8 F., *b.* = 29·705 in. 𝔎𝔅 ≏ 𝔎 — 10·701 mgr.
Δ𝔎𝔅 = 8·0645, 𝔎𝔅 displaced air = 149·997 mgr.
Δ 𝔎 = 8·3291, 𝔎 „ = 145·233
Excess by 𝔎𝔅 + 4·764
Whence in vacuum 𝔎𝔅 = 𝔎 — 5·937
And as 𝔎 = kilog. des Archives + 10·340
∴ 𝔎𝔅 = „ + 4·403

Determination of density of 𝔎𝔅.

It has been mentioned (p. 2) that the density of 𝔎𝔅 was assumed to be identical with the similar gilt brass kilograms made by Gambey, viz., V. = 124 cc., or Δ = 8·0645.

The density of 𝔎𝔅 was subsequently determined in the Standards Department by weighing it in water, with the following results:—

1870, Sept. 27. 𝔎𝔅 weighed in water ≏ brass weights series 𝔐 = 874·91394 grm. + 0·17 mgr.
Weight of 𝔎𝔅 in air, *t*=17°·78 C., *b*=770·139 mm. - - - = 1000·00000 grm.
„ in water, *t*=16·66 „ - - - = 874·91411
Difference - - - - 125·08589
Add weight of air displaced by 874·91411 grm. of brass - - = 0·13163
∴ Weight of water displaced by 𝔎𝔅 - - - = 125·21752
Log weight of water displaced - - - - - = 2·0976651
Add log W*t* - - - - = 0·0004853
2·0981504
Deduct log (1 + *e*P*t*) - - - - - - - = 0·0003738
Log V. 𝔎𝔅 - - - = 2·0977766 = 125·25 cc.
∴ Log Δ 𝔎𝔅 - - - = 0·9022234 = 7·9841

Comparison of 𝔎𝔅 with Exchequer platinum kilogram 𝔈.

The two following comparisons have been made of 𝔎𝔅 with the Exchequer platinum kilogram 𝔈; the first comparison before 𝔎𝔅 was immersed in water for the purpose of determining its density, the second after this immersion:—

1870, Sept. 27. In air, *t.* = 17°·77 C., *b.* = 770·139 mm., 𝔎𝔅 ≏ 𝔈 — 89·405 mgr.
𝔎𝔅 Δ 7·9841 displaced air - - = 153·580 mgr.
𝔈 Δ 21·13783 „ - - = 57·980
Excess by 𝔎𝔅 + 95·600
Whence in a vacuum 𝔎𝔅 = 𝔈 - - - + 6·195

1870, Sept. 28. In air, 16°·77 C., *b* = 773·416 mm., 𝔎𝔅 ≏ 𝔈 - — 90·163
𝔎𝔅 displaced air - - - = 154·800 mgr.
𝔈 „ - - - = 58·447
Excess by 𝔈 + 96·353
Whence in a vacuum 𝔎𝔅 = 𝔈 - - + 6·190

Mean 𝔎𝔅 = 𝔈 - - - - - - - + 6·192
𝔈 = kilog. des Archives - - - - - — 1·56
∴ 𝔎𝔅 = „ - - - - - + 4·632

These results are very satisfactory, as closely confirming the determination at Paris of the standard weight of 𝔎𝔅.

Some comparisons have also been made of 𝔎ℭ with the two Exchequer kilograms and with 𝔎𝔅, which tend to show that 𝔎ℭ is somewhat lighter, by three or four mgr., than it was found at Paris. It will be desirable, therefore, when an opportunity occurs, to have some further weighings of 𝔎ℭ with the platinum kilogram of the Conservatoire.

H. W. CHISHOLM,
Warden.

Standards Department,
September 1870.

APPENDIX XII.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—On the VERIFICATION of the OFFICIAL STANDARD METRIC WEIGHTS and MEASURES.

PART 1.—VERIFICATION of STANDARD METRIC WEIGHTS.
PART 2.— ,, ,, ,, MEASURES of LENGTH.
PART 3.— ,, ,, ,, MEASURES of CAPACITY.
PART 4.—CORRECTED EQUIVALENTS of the METRE and of the LITRE.

PART 1.—VERIFICATION OF STANDARD METRIC WEIGHTS.

CONTENTS.

Page
Commercial standard unit of weight for weighings in air - 170
Reference to W, the commercial standard Imperial pound ,,
The *kilogramme type laiton* 𝕷, the commercial standard of metric weight in France - - - - ,,
Its weight in air in terms of the kilogramme des archives ,,
Standard kilograms of the Standards Department:
  Platinum kilogram 𝕮 - - - - - ,,
  Gilt gun-metal kilogram 𝕶 - - - - - ,,
Relation of 𝕶 to 𝕷, and establishment of 𝕶 as our commercial standard unit of metric weight - - - - ,,
Distinction of *theoretical* and *material* commercial standards of *Imperial* and *metric* weight respectively - 171
Reverification of 𝕶 with 𝕮 - - - - - ,,
Mode of comparison - - - - - - ,,
Standard weight in a vacuum and in air of 𝕶 - - ,,
Question of propriety of gilding gun-metal or brass standard weights - - - - - - - ,,
Difference of weight in air of kilograms of various densities 172
Its effect in weighings in air - - - - - 173

Page
Verification of official standard metric weights - - 173
Metric weights, series 𝕸 and 𝕿 - - - - ,,
  Mode of their verification - - - - 174
  Actual comparison of sets 𝕸 and 𝕿 - - ,,
  Determination of their standard weight - - ,,
Comparison of standard weights of 2 kilo. to 20 k. 𝕿 - 175
Determination of their metric weight - - - ,,
Density of metric weights, series 𝕿 and 𝕸 - - ,,
Verification of the series of smaller metric weights under 1 gramme - - - - - - - 176
  Description of these small metric weights - - ,,
  Their actual comparison - - - - ,,
  And determination of standard weight - - 177
Series of 10 new standard weights of 1 kilog. each - 178
  Description of these new weights - - - ,,
  Mode of their verification - - - - ,,
  Their actual comparison - - - - ,,
  Determination of their standard weight - - 179
  Density of 𝕶 No. 1 - - - - - ,,

PART I.—VERIFICATION OF STANDARD METRIC WEIGHTS.

Commercial standard unit of weight for weighings in air.

It has been already mentioned (App. V., p. 35), that for all purposes of practical accuracy, as distinguished from scientific accuracy, the weight of any official standard or commercial weight is to be ascertained and stated by its apparent weight in air in terms of the commercial standard unit of weight established for that object, and that this standard unit is a weight of metal of the average density of commercial weights, and of the true standard weight in a vacuum.

Reference to W, the commercial standard imperial pound.

The commercial standard unit of Imperial weight in the United Kingdom for weighing in air, which was adopted by the late Standards Commission, is a *theoretical* weight of brass similar to the lost standard, weighing 7,000 grains in a vacuum, and being thus equivalent to the platinum weight legalised as the Imperial standard pound. It is designated by Prof. Miller as W, and is found to be of the density of 8·143, displacing in London, 1·03051 grains of air, log. $\Delta = 7{\cdot}07832 - 10$, ($t. = 65{\cdot}66^\circ$ F., $b. = 29{\cdot}75$ inches). As the platinum standard pound displaces only 0·39644 grains, the apparent weight of W in air of this density is 0·63407 grain less than the Imperial standard, or 6999·36593 grains. But inasmuch as in all ordinary weighings in air for commercial purposes the correction for the weight of air displaced is neglected, the weight is to be stated in terms not of the Imperial but of the commercial standard, and the weight in air of W is taken to be 7,000 grains, its true weight in a vacuum.

This theoretical commercial standard of Imperial weight is *practically* represented by the official standard avoirdupois pound of the Standards Department, verified in terms of W, and by which all the commercial weights in this kingdom when weighed in air are now regulated.

Kilogramme type laiton, 𝕷, the commercial standard of metric weight in France.

In France the commercial standard unit of metric weight for weighing in air is not a theoretical weight of metal, but a material brass kilogram, deposited at the Ministère de l'Intérieur, and known as the kilogramme type laiton. It is designated as 𝕷 by Professor Miller (p. 894). When this brass kilogram was originally constructed as the standard unit for all weighings in air, it was determined that its apparent weight in air was 88·4 mgr. less than the primary platinum standard, the kilogramme des archives. Its latest reverification in 1850 is mentioned by Professor Miller, and has also been described in Appendix II. to the Second Report of the Standards Commission, p. 25, from which it appears that this brass standard was again at that period authoritatively determined as the normal kilogram for commercial weighings.

I in terms of the kilogramme des archives.

The primary kilogramme des archives, a platinum standard weight, is designated by Professor Miller as 𝕬. It would appear that when weighed in 1850, in air, $t = 18{\cdot}9^\circ$ C. $b = 763{\cdot}8$ mm., 𝕷 ≏ 𝕬 —89·5 mgr. But the volume of 𝕷 having never been expressly determined, the exact weight of air displaced by it could only be assumed. Nevertheless, the difference between air of this density and that of air for which log. $\Delta = 7{\cdot}07832 - 10$ being exceedingly small, it may be stated with sufficiently determinate accuracy that in the latter air 𝕷 ≏ 𝕬 —88·59 mgr.

Standard kilograms of the Standards Department.

In the Standards Department there are two standard kilograms, which were verified by Professor Miller in 1844, in terms of the primary kilogramme des archives, viz., the platinum kilogram 𝕮, intended as the scientific standard of metric weight, and the gilt gun-metal kilogram 𝕶, the commercial standard of metric weight for the United Kingdom. They have been already described at page 35 of the Appendix to the Second Report of the Standards Commission.

Platinum kilogram 𝕮.

The platinum kilogram 𝕮 has been determined by Prof. Miller, by means of a direct comparison with 𝕬, to be 0·02412 grain, or 1·56 mgr. less than the primary kilogramme des archives when weighed in a vacuum. Its true scientific weight has therefore been found to be 999·99844 grammes.

Gilt gun-metal kilogram 𝕶.

The gilt gun-metal kilogram 𝕶 was also determined by Professor Miller by comparison with 𝕮 to be 3·04 mgr. less than the kilogramme des archives in a vacuum. Its true weight was thus found to be 999·99696 grammes. Its density being 8·3291, it displaced 143·92 mgr. of air, log. $\Delta = 7{\cdot}07832 - 10$, whilst 𝕬 displaced 58·31 mgr.; whence in this standard air it was found that 𝕶 ≏ 𝕬 —88·65 mgr.

Relation of 𝕶 to 𝕷, and establishment of 𝕶 as our commercial standard

Hence in air, log. $\Delta = 7{\cdot}07832 - 10$, 𝕶 = 𝕷 — 0·05 mgr., or assuming 𝕷 to be of the true weight in air of 1,000 grammes, 𝕶 = 999·99994 grammes in terms of 𝕷. Its relation to the French commercial standard of metric weight having been thus determined, and its apparent

Appendix XII.—*continued.*

unit of metric weight.

weight in air being found to be as nearly as possible the same as that of $\mathfrak{L}$, the gilt gun metal $\mathfrak{K}$ might, for all practical purposes, be properly established as the commercial standard unit of metric weight in the United Kingdom.

Distinction of *theoretical* and *material* commercial standards of *imperial* and *metric* weight.

In the establishment of a *theoretical* commercial standard of Imperial weight, this country has one advantage over France where there is a *material* commercial standard of metric weight, viz., that it is independent of any actual or material change in the standard itself. In France, the commercial standard brass kilogram was originally determined to be of the exact weight of the primary platinum standard in a vacuum, and in air, the density of which is not stated, to be 88·4 mgr. less than the standard; whilst in 1850, as already shown, the commercial standard kilogram was found to be 88·59 mgr. less in air of the specified density, and has been assumed to be 2·45 mgr. heavier than the standard in a vacuum. Neither of these determinations can, however, be absolutely depended upon, from the want of knowing the exact density of the kilogramme type laiton $\mathfrak{L}$.

REVERIFICATION of the GILT GUN-METAL KILOGRAM $\mathfrak{K}$.

Reverification of $\mathfrak{K}$ with $\mathfrak{E}$.

In the original comparison of $\mathfrak{K}$, with the platinum kilogram $\mathfrak{E}$, in 1844, by weighing in air, Prof. Miller added to $\mathfrak{K}$ some small platinum weights $\doteqdot 1{\cdot}4$ grain, as an approximate compensation for the difference of the weight of air displaced by $\mathfrak{K}$, beyond that displaced by $\mathfrak{E}$.

The net result of the weighing was found to be that in a vacuum $\mathfrak{K} = \mathfrak{E} - 0{\cdot}02284$ grain (1·48 mgr.), and that in standard air, log. $\Delta = 7{\cdot}07832 - 10$, as $\mathfrak{K}$ displaced 2·2211 grains (143·92 mgr.), whilst $\mathfrak{E}$ displaced 0·87481 grain (56·68 mgr.), $\mathfrak{K} = \mathfrak{E} - 1{\cdot}36913$ grain (88·72 mgr.).

Mode of comparison.

In the reverification of $\mathfrak{K}$, now effected by again comparing it with $\mathfrak{E}$, similar balance weights were added to $\mathfrak{K}$, viz.:—

Decimal standard grain		1·	= 0·99989	grain.
„	„	0·2	= 0·20040	„
„	„	0·06	= 0·06010	„
		1·26	= 1·26039	„
			(66·48 mgr.)	

As there were then no accurately verified small metric weights in the Standards Department, the small Imperial grain weights were necessarily used for the comparison of the two kilograms, the difference being found in Imperial grains. Their equivalents in metric weight were subsequently ascertained.

Two comparisons were made on separate days and under different circumstances. For the first comparison, Oertling's balance No. 3 was used, with barometer No. 691, and Troughton and Simms' thermometers Nos. 1 and 2. For the second comparison, Barrow's balance was used, with barometer No. 417, and Negretti and Zambra's thermometers Nos. 12321 and 12322.

The weighings were made in the same manner as those of the several Imperial standard weights, and they are recorded in the same formula as the comparison of the two platinum troy pounds T and RS, stated at p. 18 of Paper X., three weighings of each weight being taken before changing the weights in the pans.

The actual comparison of these two standards and the results are as follows:—

COMPARISON of $\mathfrak{K}$ with $\mathfrak{E}$.

No. of Comparison.	Date.	Number of Weighings.	Balance used.	Value of One Division.	Result of Weighing.	Therm.	Bar.
	1869.					C.	mm.
(1.) - -	June 8 -	12	Oertling's No. 3	0·00434 gr.	$\mathfrak{K} \simeq \mathfrak{E} - 78{\cdot}95$ mgr.	16°·64	768·133
(2.) - -	July 6 -	15	Barrow's - -	0·01307 „	$\mathfrak{K} \simeq \mathfrak{E} + 74{\cdot}74$ „	17°·50	759·929

REDUCTIONS of WEIGHINGS.

No.	Standard.	Weight of Air displaced.	Excess of Air displaced.	Result in a Vacuum.	Mean Result.
(1.) -	$\mathfrak{K}$	147·45 mgr.			
	$\mathfrak{E}$	58·07	89·38 mgr.	$\mathfrak{K} = \mathfrak{E} + 10{\cdot}42$ mgr.	$\mathfrak{K} = \mathfrak{E} + 11{\cdot}90$ mgr.
(2.) -	$\mathfrak{K}$	145·37			
	$\mathfrak{E}$	57·26	88·11 „	$\mathfrak{K} = \mathfrak{E} + 13{\cdot}37$ „	

Upon the original comparison of $\mathfrak{K}$ with $\mathfrak{E}$, Prof. Miller found that in a vacuum $\mathfrak{K} = \mathfrak{E} - 0{\cdot}02284$ grain (0·00148 gramme), and $\mathfrak{K} = \mathfrak{A} - 0{\cdot}04696$ grain, or 0·00304 gramme; whence $\mathfrak{K} = 999{\cdot}99696$ grammes.

In standard air, for which log. $\Delta = 7{\cdot}07832 - 10$, $\mathfrak{K}$ displaced 2·2211 grains, or 0·14392 gramme, $\mathfrak{A} - 1{\cdot}4$ grain of platinum displaced 0·89981 grain, or 0·05831 gramme.

The difference between the result of the comparison now made and that of Prof. Miller is as follows:—

In 1844 $\mathfrak{K} = \mathfrak{E} - 0{\cdot}02284$ grain or $-$ 1·48 mgr. in a vacuum.
In 1869 $\mathfrak{K} = \mathfrak{E} + 0{\cdot}18359$ grain or + 11·90 mgr. „ „

Difference in 1869 + 0·20643 grain or 13·38 mgr.

And thus assuming the platinum kilogram $\mathfrak{E}$ to be unaltered, $\mathfrak{K}$ appears to have gained from oxidation of the gun metal, or other cause, in 25 years, 13·38 mgr., or 0·20643 grain.

Standard weight in a vacuum of $\mathfrak{K}$.

The standard weight of the metric commercial standard kilogram $\mathfrak{K}$, in terms of the primary metric standard $\mathfrak{A}$, may therefore now be stated as follows:—

In a vacuum, $\mathfrak{E} = \mathfrak{A} - 0{\cdot}00156$ grm. or 999·99844 grm.
„ $\mathfrak{K} = \mathfrak{A} + 0{\cdot}01034$. „ or 1000·01034 „

It will have been seen in App. XI., p. 168, that the result of a subsequent comparison on 30th Nov. 1869, of $\mathfrak{K}$ with the gilt brass kilogram $\mathfrak{K}\ \mathfrak{B}$, verified at Paris and determined to be 4·13 mgr. heavier than $\mathfrak{A}$, shews $\mathfrak{K} = \mathfrak{K}\ \mathfrak{B} + 5{\cdot}94$ mgr., whence $\mathfrak{K} = \mathfrak{A} + 10{\cdot}07$ mgr., being a very close approximation to the result above stated.

And in air.

In air log. $\Delta = 7{\cdot}07832 - 10$, $\mathfrak{K} - 10{\cdot}34$ mgr. $\doteqdot \mathfrak{L} + 2{\cdot}98$ mgr. $\mathfrak{L}$, as already stated, being assumed to be 2·45 mgr. heavier than in a vacuum. In all comparisons made by weighings in air with $\mathfrak{K}$, allowance should therefore be made for the excess of 0·01034 gramme in its standard weight in air, $\mathfrak{K}$ being taken as = 1000·01034 grammes (or 15432·50801 Imperial grains).

Question of propriety of gilding gun-metal or brass standard weights.

The propriety of gilding gun-metal or brass standard weights is doubtful. The practice is open to the objection that unless the operation of gilding is very skilfully executed, and a sufficient quantity of gold laid on, numerous minute interstices will be found in the coating of gold deposited upon the standards. These interstices may not be large enough to affect the apparently smooth surface of the weight, but they allow the air to penetrate to the incased gun metal or brass and thus to oxidise it. The interstices are also themselves liable to be filled up in course of time with dust and dirt. The gilt gun-metal kilogram $\mathfrak{K}$, and the gilt gun-metal 10 lbs. standard, when examined with a magnifying glass, appear to have many such small cavities or holes on their surfaces, but the gilt gun-metal standard pounds are found to be free from blemish.

Appendix XII.—*continued.*

Difference of weight in air of kilograms of various densities.

Before proceeding with the details of the verification of the series of metric standard weights, which are made of brass, as this verification must be based upon the gilt gun-metal kilogram 𝕶, attention may be drawn to the difference of the weight in air not only of single kilograms, but of the largest metric weights of 20 kilograms, when composed of various metals or other materials differing in their density.

It has been shown in App. V., p. 31, that there is a considerable difference in the densities of various weights composed of the same description of metal, and a table is given of the corresponding differences in the weight of air displaced by several Imperial pound weights composed of various metals.

It may here be desirable to give similar information as to the difference in the weight of air displaced by kilograms composed of various metals and other materials.

In adopting the new uniform standard temperature of 62° F. and barometric pressure of 30 inches, as recommended by the Standards Commission for all weighings in air, in place of that provisionally adopted by Professor Miller during the construction of the Imperial standard pound, as having been the mean temperature and pressure during Schumacher's comparisons made in 1829 with the lost standard, viz., $t=65^{\circ}\cdot66$ F. $b=29\cdot75$ in., the results of this change in the standard air, as well as of other variations in the temperature and atmospheric pressure as affecting the standard weight of kilograms of platinum, brass, bronze, cast iron, and quartz or glass, arising from the differences of air displaced by them, may be seen from the following table:—

—	Weight of Air displaced by primary Kilograms, viz.:—		
	Platinum Kilo. des Archives 𝕬 $\Delta=20\cdot5487$ $\log \Delta=1\cdot3127839$.	Platinum Exchequer Kilogram 𝕰 $\Delta=21\cdot13791$ $\log. \Delta=1\cdot3250621$.	French commercial Brass Standard 𝕷 Assumed $\Delta=8\cdot2063$ $\log \Delta=0\cdot9045152$.
	mgr.	mgr.	mgr.
Air $t=65^{\circ}\cdot66$ F. $b=29\cdot75$ in., $\log \Delta=7\cdot0783216-10$ - -	58·31	56·69	149·36
Air $t=62^{\circ}$ F. $b=30$ in. $\log \Delta=7\cdot0852825-10$ - -	59·25	57·60	151·75

—	Weight of Air displaced by other Kilograms, viz. :—				
	Gilt Gun-metal (Baily's) of the Density of 𝕶. $\Delta=8\cdot3291$ $\log \Delta=0\cdot9205981$.	Gun-metal (Baily's) of maximum Density. $\Delta=8\cdot558$ $\log \Delta=0\cdot9323723$.	Brass of minimum Density. $\Delta=7\cdot872$ $\log \Delta=0\cdot8602182$.	Cast Iron of average Density. $\Delta=7\cdot127$ $\log \Delta=0\cdot8529068$.	Quartz, or Glass of Density of 𝕼. $\Delta=2\cdot651$ $\log \Delta=0\cdot4234033$.
	mgr.	mgr.	mgr.	mgr.	mgr.
Air $t=65\cdot66^{\circ}$ F. $b=29\cdot75$ in., $\log \Delta=7\cdot0783216-10$	143·92	140·07	152·28	168·13	452·05
Air $t=62^{\circ}$ F. $b=30$ in. $\log \Delta=7\cdot0852825-10$	146·23	142·32	154·73	170·84	459·32
Air $t=62^{\circ}$ F. $b=29$ in. $\log \Delta=7\cdot0705187-10$	141·35	137·57	149·55	165·13	443·97
Air $t=32^{\circ}$ F. $b=30$ in. $\log \Delta=7\cdot1123704-10$	155·51	151·35	164·54	181·74	488·62

The density of the Imperial commercial brass standard lb. $W=8\cdot143$ does not differ materially from the assumed density of the French standard 𝕷, and both nearly represent the average density of brass or bronze weights, shown by Professor Miller to be nearly 8·151, that being the mean density of the numerous brass and bronze weights brought under his notice, the densities of which had been determined.

The densities of two ordinary japanned iron commercial weights adjusted with lead has been ascertained by weighing them in water in the Standards Department. Previous to the weighing they were boiled in the water in order to expel the air. The first was a 1 lb. weight, and its density was found to be 7·159. The second was a 1 kilogram weight, and its density was 7·095. They were new weights supplied by two different London makers. The mean density is 7·127.

It may be seen from the Annuaire du Bureau des Longitudes that the average density of glass is 2·505, this being the mean density of nine stated descriptions of glass, the maximum density of which is 2·436 and the maximum 2·657. The density of the glass Imperial weights recently constructed by Messrs. Chance and Mr. Oertling is 2·5179.

It follows from these tabular statements of the weight of air displaced by the several kilograms that—

—	In a Vacuum.	In Air.		
	—	$t=65^{\circ}\cdot66$ F. $b=29\cdot75$ in. ($18^{\circ}\cdot7$ C) (755·636 mm.)	$t=62^{\circ}$ F. $b=30$ in. ($16^{\circ}\cdot6$ C.) (761·986 mm.)	Difference of compared Kilogram.
	mgr.	mgr.	mgr.	mgr.
𝕰 = 𝕬	−1·56	+ 0·06	+ 0·09	0·03 heavier.
𝕷 = 𝕬	+2·45	−88·59	−90·05	1·46 lighter.
𝕶 −10·34 mgr. = 𝕬	+0·00	−85·61	−86·98	1·37 „
𝕶 −10·34 „ = 𝕰	+1·56	−85·67	−87·07	1·40 „
𝕶 −10·34 „ = 𝕷	−2·45	+ 2·98	+ 3·07	0·09 heavier.

Appendix XII.—*continued.*

KILOGRAMS ASSUMED TO BE EQUAL IN A VACUUM.	In Air.				
	t=65°·66 F. b=29·75 in. (18°·7 C.) (755·636 mm.)	t=62° F. b=30 in. (16°·6 C.) (761·986 mm.)	t=62° F. b=29 in. (736·586 mm.)	t=32° F. b=30 in. (0° C.)	Difference of compared Kilogram.
	mgr.	mgr.	mgr.	mgr.	mgr.
Brass or bronze of maximum density = 𝔎	+ 3·85	+ 3·91	—	—	0·06 heavier.
	—	+ 3·91	+ 3·78	—	0·13 lighter.
	—	+ 3·91	—	+ 4·16	0·25 heavier.
Brass or bronze of minimum density = 𝔎	− 8·36	− 8·50	—	—	0·14 lighter.
	—	− 8·50	− 8·20	—	0·30 heavier.
	—	− 8·50	—	− 9·03	0·53 lighter.
Cast iron of average density = 𝔎	− 24·21	− 24·61	—	—	0·40 „
	—	− 24·61	− 23·78	—	0·83 heavier.
	—	− 24·61	—	− 26·23	1·62 lighter.
Quartz or glass of average density = 𝔎	−308·13	+313·09	—	—	4·96 „
	—	−313·09	−302·62	—	10·47 heavier.
	—	−313·09	—	−333·11	20·02 lighter.

The following results are shown from these tables:—

1. That the substitution of the new standard air can make no appreciable difference in the standard weight of 𝔎 in its relation to 𝔏 that can sensibly affect commercial metric weights, the actual difference being less than 0·1 mgr. in a kilogram weight.

2. That it can also make no appreciable difference in the weight of commercial metric weights of brass, bronze, or iron as compared with 𝔎, or its copies of brass or bronze of average density, the greatest difference being only 0·4 mgr. in a kilogram weight.

3. That a somewhat greater difference appears in the weight of glass standard metric weights as compared with 𝔎, although no sensible difference would arise upon the comparison of such weights with the standard quartz kilogram 𝔔.

4. That a variation of one inch from the standard barometric pressure of 30 inches, either higher or lower, when the temperature remained unaltered, would not cause any apparent difference of any brass or bronze kilogram compared with a brass or bronze standard weight that would exceed 0·4 mgr., or in a similar comparison with a cast iron weight of average density, that would exceed 0·8 mgr.; and that such differences could hardly exceed 0·6 mgr. and 1·2 mgr. respectively, in extreme variations of barometric pressure.

5. That a variation of 30° Fahr. from the standard temperature of 62°, either higher or lower, when the barometic pressure remained unaltered, would not affect the apparent weight of a brass or bronze kilogram compared with a brass or bronze standard weight to a greater extent than 0·8 mgr., nor of a cast iron kilogram similarly compared, than 1·6 mgr.; showing a corresponding difference for 1° Fahr. of 0·026 mgr. and 0·054 mgr. respectively.

6. That the greatest variations from the standard temperature and the standard barometric pressure cannot affect the apparent weight of a brass or bronze kilogram compared with a brass or bronze standard weight to a greater extent than 1·2 mgr.; nor of a cast iron kilogram of average density than 2·4 mgr.

7. That such differences in 20 kilogram weights of brass or iron, or the largest denominations, cannot exceed 25 mgr. and 48 mgr. respectively.

8. That such greatest difference in the comparison of solid glass weights with brass or bronze weights would not exceed 35 mgr. in a kilogram, or about $\frac{1}{30000}$th of the weight, and might be altogether avoided by the use of glass standard weights.

The corresponding variations of the centigrade thermometer and metric barometer, and differences in weight caused by them, would be as follows:—

The greatest variation from the mean barometric pressure being 37·100 mm. (1½ in.), a change to that extent with unaltered temperature affecting the apparent weight of a brass kilo. to the extent of 0·5 mgr. and a cast iron kilo. of 1·0 mgr. would be equivalent for every variation of 10 mm. to about 0·14 mgr. and 0·28 mgr. respectively.

A variation of temperature of 18·70 C. (30° F.) with unaltered barometric pressure, causing corresponding differences of 0·78 mgr. and 1·44 mgr. would be equivalent for every 1° C. to about 0·042 mgr. and 0·071 mgr. in a brass or iron kilogram.

It is to be observed that the greatest possible difference of weight arising *in weighings in air* from difference of density of the compared weights, and consequently of air displaced, is only a small proportion, about $\frac{1}{20}$ only, of the difference between weighings in air and in a vacuum, taking the variations of the barometer as being limited between 28·5 inches and 30·5 inches, or 1½ inches in 30 inches, and the variations of the thermometer as ranging from 32° to 92° Fahr.

Its effect in weighings in air.

It is evident therefore that for all commercial weighings, any correction for the effect of difference of density upon the weight of air displaced by the several weights may be utterly disregarded. But in the more accurate comparison of standard weights in the Standards Department, any considerable difference in the densities of these standard weights must cause a certain amount of discordance in their comparisons on different days, when a change of temperature and of the barometer has occurred. For this reason, the temperature and barometric pressure should always be noted and the necessary allowance made.

VERIFICATION of OFFICIAL STANDARD METRIC WEIGHTS.

Metric weights. Series 𝔐 and ℭ.

The official standard metric weights to be now verified are as follows:—

1. The Paris metric standards transmitted by the French Government in 1818, and received from the Mint in 1868, at the same time with the other foreign standard weights. They are made of brass, and the kilogram is of cylindrical shape with a knob, its surface being much oxidized. The smaller weights are rectangular in shape, and are somewhat discoloured by oxidation, but they are in other respects in good condition. This set will be designated 𝔐, and will be serviceable as auxiliary standards, their weights not being likely to alter further from oxidation. Each of these brass weights is marked "Fortin, Paris," and bears the stamp of a fleur-de-lis. The weights are 13 in number, and are marked respectively with their denominations of,—

1 kilogram.
5, 2, 1, 1, hectog.
5, 2, 1, 1, dekag.
5, 2, 1, 1, gram.

Each duplicate of the hectogram, dekagram, and gramme, has a small dot under the figure 1, and these duplicates will be distinguished as $𝔐^1$.

2. The set of metric weights made by Deleuil of Paris, purchased from Messrs. Tylor. They are 14 in number, being marked respectively,—

20, 10, 5, 2, 1 kilog.
500, 200, 100, 50, 20, 10, 5, 2, 1 gram.

in conformity with the French Regulations for metric weights, stated at page 66 of the Appendix 2, to the Second Report of the Commission. These standard weights are made of brass being of cylindrical shape with a knob, and are bright and in good condition. They will be distinguished as ℭ.

3. Three new sets of the smaller metric weights, recently procured from Deleuil at Paris. They are made of thin platinum cut square, with one corner turned up, and each set is contained in a small mahogany box with separate divisions, the weights of each set being respectively distinguished as 𝔄, 𝔅, and ℭ. The cost of the three sets in Paris was 66 francs. There are fourteen weights in each set, marked respectively with their denominations,—

5, 2, 1, 1 deci. (decigrams),
5, 2, 1, 1 C.G. (centigrams),
5, 2, 1, 1 - (milligrams),

with two half milligrams having no mark.

Appendix XII.—*continued.*

Mode of their verification.

The verification of the official standard metric weights has been based upon the commercial standard kilogram 𝔎, the weight of which in air has been determined to be 1000·01034 grammes. The verification of the smaller metric weights under a gramme was necessarily deferred until that of the larger weights was completed. In the meantime it was necessary to make use, in all the first departmental comparisons of metric weights, of the verified imperial grain weights, as balance weights, and thus to ascertain the differences of the metric weights in grains, the results in metric quantities being subsequently shown by conversions into fractions of a gramme.

Actual comparisons of sets 𝔐 and ℭ, 1 kilog. to 1 gramme.

In the following comparisons of the metric weights 𝔐, and of 1 kilog. to 1 gramme of the series ℭ, 12 weighings were made for each comparison. Balance No. 3 was used for comparisons No. 1 to No. 25, and balance No. 4 for comparisons No. 26 to 36.

Comparisons of Metric Standard Weights, from a Kilogram to One Gramme.

No.	Date of Comparison.	Results of Weighings. Compared	≏ Comparing Standard.	Value of One Division of Balance.	Difference of compared Standard.	
	1869.	Grammes.	Grammes.	Grains.	In Grains.	In Milligrams.
(1)	April 28	1,000 𝔐 ≏	1,000 𝔎	0·00462	−0·13074	− 8·47
(2)	,, 30	1,000 ℭ ≏	1,000 𝔎.	0·00490	−0·15791	−10·23
(3)	,, 28	1,000 𝔐 ≏	1,000 ℭ	0·00545	+0·03089	+ 2·00
(4)	September 3	500 𝔐 + 500 ℭ ≏	1,000 𝔐	0·00637	−0·10912	− 7·07
(5)	,, 6	500 𝔐 + 500 ℭ ≏	1,000 ℭ	0·00421	−0·05394	− 3·49
(6)	April 30	500 𝔐 ≏	500 ℭ	0·00190	−0·03870	− 2·51
(7)	May 21	200 𝔐 + 200 ℭ + 100 ℭ ≏	500 ℭ	0·00202	+0·15651	+10·14
(8)	September 8	200 𝔐 + 100 𝔐 + 100 𝔐^1 + 100 ℭ ≏	500 𝔐	0·00228	+0·08273	+ 5·36
(9)	April 29	200 𝔐 ≏	200 ℭ	0·00169	−0·09120	− 5·91
(10)	,, 24	100 𝔐 + 100 ℭ ≏	200 ℭ	0·00163	−0·08594	− 5·57
(11)	,, 23	100 𝔐 ≏	100 ℭ	0·00190	−0·03633	− 2·35
(12)	,, ,,	100 𝔐^1 ≏	100 𝔐	0·00165	+0·00216	+ 0·14
(13)	September 6	500 ℭ + 200 ℭ + 200 𝔐 + 100 ℭ ≏	1,000 ℭ	0·00742	+0·17142	+11·11
(14)	,, ,,	500 𝔐 + 200 𝔐 + 100 𝔐 + 100 𝔐^1 + 100 ℭ ≏	1,000 𝔐	0·00548	−0·06351	− 4·11
(15)	,, 8	50 𝔐 + 50 ℭ ≏	100 ℭ	0·00207	−0·03951	− 2·56
(16)	,, 9	50 𝔐 + 50 ℭ ≏	100 𝔐	0·00186	+0·00015	+ 0·01
(17)	,, ,,	50 𝔐 ≏	50 ℭ	0·00212	−0·07959	− 5·16
(18)	,, ,,	20 𝔐 + 20 ℭ + 10 ℭ ≏	50 ℭ	0·00200	−0·01515	− 0·98
(19)	,, ,,	20 𝔐 + 10 𝔐 + 10 𝔐^1 + 10 ℭ ≏	50 𝔐	0·00174	+0·06754	+ 4·38
(20)	,, 10	20 𝔐 ≏	20 ℭ	0·00194	−0·01544	− 1·00
(21)	,, ,,	10 ℭ + 10 𝔐 ≏	20 ℭ	0·00195	−0·00165	− 0·11
(22)	,, ,,	10 𝔐 ≏	10 ℭ	0·00186	+0·00673	+ 0·44
(23)	,, ,,	10 𝔐 ≏	10 𝔐^1	0·00196	+0·00451	+ 0·29
(24)	,, 12	50 ℭ + 20 ℭ + 20 𝔐 + 10 ℭ ≏	100 ℭ	0·00163	+0·03173	+ 2·06
(25)	,, ,,	50 𝔐 + 20 𝔐 + 10 𝔐 + 10 𝔐^1 + 10 ℭ ≏	100 𝔐	0·00167	−0·01364	− 0·88
(26)	,, 18	5 𝔐 + 5 ℭ ≏	10 ℭ	0·00084	−0·00530	− 0·34
(27)	,, ,,	5 𝔐 + 5 ℭ ≏	10 𝔐	0·00092	−0·01206	− 0·78
(28)	,, ,,	5 𝔐 ≏	5 ℭ	0·00093	−0·01277	− 0·83
(29)	,, 20	2 𝔐 + 2 ℭ + 1 ℭ ≏	5 ℭ	0·00095	−0·00348	− 0·22
(30)	,, ,,	2 𝔐 + 1 𝔐 + 1 𝔐^1 + 1 ℭ ≏	5 𝔐	0·00085	+0·01273	+ 0·82
(31)	,, ,,	2 𝔐 ≏	2 ℭ	0·00091	−0·00304	− 0·20
(32)	,, ,,	1 𝔐 + 1 ℭ ≏	2 ℭ	0·00092	−0·00141	− 0·09
(33)	,, 21	1 𝔐 ≏	1 ℭ	0·00090	+0·00295	+ 0·19
(34)	,, ,,	1 𝔐 ≏	1 𝔐^1	0·00090	−0·00089	− 0·06
(35)	,, ,,	5 ℭ + 2 ℭ + 2 𝔐 + 1 ℭ ≏	10 ℭ	0·00087	+0·00378	+ 0·24
(36)	,, ,,	5 𝔐 + 2 𝔐 + 1 𝔐 + 1 𝔐^1 + 1 ℭ ≏	10 𝔐	0·00085	−0·01349	− 0·87

Determination of their standard weight.

From these comparisons the following values of each of the standard Metric weights have been deduced :—

	Series 𝔐.	Grammes.
(1)	Kilo. =	1000·00187
(4) (5) (6)	500 =	499·99660
(7) (8) (9) (10) (11) (12)	200 =	200·00085
	100 =	99·99942
	100^1 =	99·99957
(15) (16) (17)	50 =	49·99708
(18) (19) (20) (21) (22) (23)	20 =	20·00005
	10 =	10·00070
	10^1 =	10·00041
(26) (27) (28)	5 =	4·99954
(29) (30) (31) (32) (33) (34)	2 =	2·00001
	1 =	1·00016
	1^1 =	1·00022
	Series ℭ.	
(2)	Kilo. =	1000·00011
(4) (5) (6)	500 =	499·99911
	200 =	200·00673
	100 =	100·00177
	50 =	50·00224
	20 =	20·00103
	10 =	10·00025
	5 =	5·00037
	2 =	2·00020
	1 =	0·99996

The values of each series of the weights under a kilogram have been found by taking the mean weight as deduced from both the kilograms 𝔐 and .

Comparisons (3) (13) (14) (24) (25) (35) (36) have been used as proofs of the values thus found, viz. :—

Kilo. 𝔐 = 1000·00187 grammes.
Kilo. ℭ = 1000·00011

∴ Kilo. 𝔐 = Kilog. ℭ + 0·00176
(3) Kilo. 𝔐 = Kilo. ℭ + 0·00200

Difference −0·00026

500 ℭ + 200 ℭ + 200 𝔐 + 100 ℭ = 1000·00847
(13) 500 ℭ + 200 ℭ + 200 𝔐 + 100 ℭ = 1000·01122

Difference - - - 0·00275

500 𝔐 + 200 𝔐 + 100 𝔐 + 100 𝔐^1 + 100 ℭ = 999·99822
(14) Do. do. = 999·99775

Difference - - - - 0·00057

50 ℭ + 20 ℭ + 20 𝔐 + 10 ℭ = 100·00357 grammes
(15) Do. do. = 100·00383

Difference - - - 0·00026

50 𝔐 + 20 𝔐 + 10 𝔐 + 10 𝔐^1 + 10 ℭ = 99·99849
(25) Do. do. = 99·99854

Difference - - - 0·00005

Appendix XII.—*continued.*

5 𝕮 + 2 𝕮 + 2 𝕸 + 1 𝕮 = 10·00053 grammes.
(35) Do. = 10·00050

Difference - + 0·00003

5 𝕸 + 2 𝕸 + 1 𝕸 + 1 𝕸¹ + 1 𝕮 = 9·99989
(36) Do. do. = 9·99982

Difference - - + 0·00007

In all these cases the differences amongst so many weighings are too small to be regarded.

VERIFICATION of METRIC STANDARD WEIGHTS 𝕮, 2 Kilo. to 20 Kilo.

Verification of 2 kilo. to 20 kilo. 𝕮.

The verification of these brass standards has been based on the 10 new kilograms of Baily's metal, the comparisons having been made before the standard weight of each of these new kilograms had been accurately determined. After this determination had been completed, as will be subsequently shown, the requisite corrections of these larger Metric weights of Series 𝕮 were made.

COMPARISONS of 2 Kilo. to 20 Kilo. 𝕮.

No.	Date.	Compared.	Comparing Standard.	Divisions of Balance.	Balance used.	Value of One Division in Grains.	Difference of compared Standard.	
							In Grains.	In Milligrams.
	1870.					Grains.	Grains.	Mgr.
1	April 19	2 𝕮	≏ 1 𝕮, 1 𝕸 - -	− 1·375	No. 2	0·06771	−0·09310	− 0·60
2	,,	2 𝕮	≏ 𝕶, Nos. 1 and 2 -	− 5·000	,,	0·06658	−0·33293	− 21·57
3	,,	5 𝕮	≏ 1 𝕮, 1 𝕸, 𝕶, 2 𝕮 -	− 2·250	,,	0·10900	−0·24525	− 15·89
4	,,	5 𝕮	≏ 𝕶, Nos. 1, 2, 3, 4, 5 -	− 6·125	,,	0·06658	−0·40784	− 26·43
5	April 14	10 𝕮	≏ 5 𝕮, 2 𝕮, 1 𝕮, 1 𝕸, 𝕶.	+ 3·250	No. 1	0·17390	+0·56517	+ 36·62
6	,,	10 𝕮	≏ 𝕶, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.	− 4·575	,,	0·17160	−0·78507	− 50·87
7	,,	20 𝕮	≏ 10 𝕮, 5 𝕮, 2 𝕮, 1 𝕮, 1 𝕸, 𝕶.	+ 24·750	,,	0·20250	+5·01187	+324·76
8	,,	20 𝕮	≏ 10 𝕮 + 𝕶, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.	+ 17·700	,,	0·14410	+2·55057	+165·27

RESULTS of COMPARISONS.

——	——	Ascertained Weight.	Mean.	Mean ascertained Error.
		Grammes.	Grammes.	Grammes.
(1.)	2 𝕮	= 2,000·00503	2,000·00048	+ 0·00048
(2.)	2 𝕮	= 1,999·99594		
(3.)	5 𝕮	= 5,000·01956	5,000·00358	+ 0·00358
(4.)	5 𝕮	= 4,999·98761		
(5.)	10 𝕮	= 10,000·04008	10,000·04654	+ 0·04654
(6.)	10 𝕮	= 10,000·05300		
(7.)	20 𝕮	= 20,000·40276	20,000·39054	+ 0·39054
(8.)	20 𝕮	= 20,000·37832		

DETERMINATION of the DENSITY of the BRASS METRIC STANDARD WEIGHTS, Series 𝕸 and 𝕮.

Density of metric weights 𝕸 and 𝕮.

With the view to the use of the Series 𝕸 and 𝕮 of brass Metric weights for the verification of the brass official standard Metric measures of capacity, by weighing their contents of distilled water, it has been considered desirable to ascertain the density of the brass of which they are composed by weighing the flat rectangular brass half kilogram 𝕸, and the cylindrical brass kilogram with knob 𝕮, in water.

Date.	Weighings.	Result in Division.	Value of 1 Division of No. 4 Balance.	Result in Grammes.
1870.		div.	grm.	grm.
September 21 -	1 kilo. 𝕮 weighed in water ≏ 500, 200, 100, 50, 20, 5, 2 grammes 𝕸 + 1 dgr. 1¹ dgr. (=877·194 grm.) - - -	+ 1·25	0·064	+ 0·08
October 21 -	500 grm. 𝕸 weighed in water ≏ 439·438 grammes - -	−20·525	0·179	−0·00

mm. grm.
Weight of 1 kilo. 𝕮 in air, $t = 16^{\circ}\cdot39$ C., $b = 767\cdot88$ = 1000·000
,, in water ,, ,, 877·274

122·726
Add weight of air displaced by 877·274 grm., brass weights, mean Δ 8·151 0·133

∴ Weight of water displaced by 1 kilo. 𝕮 - - - - - 122·859

Appendix XII.—*continued.*

Log. weight of water displaced by 1 kilo. 𝔗 - - - -	=2·0894070
Add log. W_t - - - - - - - - -	0·0004654
	2·0898724
Deduct log. $(1+e\mathfrak{B}_t)$ - - - - - - - - -	0·0003678
log. v 1 kilo. 𝔗 - - - -	2·0895046
Deduct from log. weight in air of 1 kilo. 𝔗 - - - -	3·0000000
∴ log. Δ 1 kilo. 𝔗 - - - - -	0·9104954
or Δ 1 kilo. 𝔗 - -	8·1376
	grm.
Weight of 500 grm. 𝔐 in air (t = 15°·56 C., b = 760·72 mm.) =	499·996
" in water (t = 15·00 C.) - -	439·434
	60·562
Add weight of air displaced by 439·434 grm. brass weights, mean Δ = 8·151 =	0·066
∴ Weight of water displaced by 500 grm. 𝔐 - - -	60·628
Log. weight of water displaced by 500 grm. 𝔐 - - - -	1·7826732
Add log. W^t - - - - - - - - - -	0·0003708
	1·7830440
Deduct log. $(1 + e\mathfrak{B}^t)$ - - - - - - - -	0·0003364
Log. v 500 grm. 𝔐 - - - -	1·7827076
Deduct from log. weight in air of 500 grm. 𝔐 - - - - -	2·6989665
Log. Δ 500 grm. 𝔐 - - - =	0·9162589

∴ Δ 500 grm. 𝔐 = 8·2463

VERIFICATION of the SMALLER METRIC WEIGHTS from 5 decigram to 0·5 mgr.

Verification of the series of small metric weights.

These small weights are in three boxes, marked respectively 𝔄, 𝔅, ℭ, and by these letters the weights are distinguished in these weighings. Each box contains the following weights: 5, 2, 1, 1 decigram; 5, 2, 1, 1 centigram; 5, 2, 1, 1, 0·5, 0·5 milligram. Each duplicate weight, 1, may be known by a small figure 1 stamped or marked in the corner of the weight. The sets 𝔄, 𝔅, ℭ may be distinguished from each other by dots stamped on the weights, thus 𝔄 set has no dots, 𝔅 set has one dot, ℭ set has two dots in one corner of each weight. But as these marks are very slight on the small weights below 1 centigram, it is necessary to take care not to mix the weights, the pans of the balance in which they were weighed were divided by lines into three compartments, one compartment being used for each set of these small metric weights.

It was necessary in these comparisons to estimate the value of one division of the balance in grains, no standard Metric weight below 1 gramme having been accurately verified for departmental use; but in all future comparisons it is proposed to use the set 𝔅 from 5 deci. to 0·5 mgr. as official balance weights, ℭ set being used as counterpoise or balance weights, and 𝔄 set being kept as standards for reference.

COMPARISONS.

No.	Date.	Compared		≏ Comparing Standard.	Difference of compared Standard in Divisions.	Value of one Division. No. 4 Balance.	Difference.	
							In Grains.	In Milligrams.
	1870.	*Decigrams, 𝔄 and 𝔅.*		gramme.		grains.		
(1)	April 13	5 d𝔄 + 5 d𝔅	≏	1 𝔗	− 9·250	0·00088	−0·00819	−0·53
(2)	" "	5 d𝔄 + 5 d𝔅	≏	$1\,\mathfrak{M}^1$	−14·675	0·00088	−0·01299	−0·84
(3)	" "	5 d𝔄	≏	5 d𝔅	+13·200	0·00092	+0·01225	+0·79
(4)	" "	2 d𝔄 + 2 d𝔅 + 1 d𝔄	≏	5 d𝔄	− 9·275	0·00092	−0·00861	−0·56
(5)	" "	$2\,d\mathfrak{A} + 1\,d\mathfrak{A} + 1\,d^1\mathfrak{A} + 1\,d\mathfrak{B}$	≏	5 d𝔅	+ 9·525	0·00092	+0·00884	+0·57
(6)	" "	2 d𝔄	≏	2 d𝔅	− 1·775	0·00099	−0·00176	−0·11
(7)	" "	1 d𝔄 + 1 d𝔅	≏	2 d𝔅	+ 0·825	0·00099	+0·00081	+0·05
(8)	" "	1 d𝔄	≏	$1\,d\mathfrak{A}^1$	− 5·900	0·00093	−0·00552	−0·36
(9)	" "	1 d𝔄	≏	1 d𝔅	− 8·150	0·00093	−0·00763	−0·49
(10)	" "	5 d𝔄 + 2 d𝔅 + 2 d𝔄 + 1 d𝔄	≏	1 𝔗	− 6·700	0·00091	−0·00611	−0·40
(11)	" "	$5\,d\mathfrak{B} + 2\,d\mathfrak{B} + 1\,d^1\mathfrak{A} + 1\,d\mathfrak{A} + 1\,d\mathfrak{B}$	≏	$1\,\mathfrak{M}^1$	−16·350*	0·00091	−0·01490	−0·96
		Centigrams, 𝔄 and 𝔅.						
(12)	" "	5 c𝔄 + 5 c𝔅	≏	1 d𝔄	+ 6·500	0·00095	+0·00618	+0·40
(13)	" "	5 c𝔄 + 5 c𝔅	≏	1 d𝔅	− 2·450	0·00095	−0·00233	−0·15
(14)	" "	5 c𝔄	≏	5 c𝔅	− 1·025	0·00090	−0·00093	−0·06
(15)	" "	2 c𝔄 + 2 c𝔅 + 1 c𝔄	≏	5 c𝔄	− 5·475	0·00090	−0·00497	−0·32
(16)	" "	$2\,c\mathfrak{A} + 1\,c\mathfrak{A} + 1\,c^1\mathfrak{A} + 1\,c\mathfrak{B}$	≏	5 c𝔅	+ 2·725	0·00090	+0·00247	+0·15
(17)	" "	2 c𝔄	≏	2 c𝔅	+ 3·325	0·00089	+0·00298	+0·19
(18)	" "	1 c𝔄 + 1 c𝔅	≏	2 c𝔅	+ 8·575	0·00089	+0·00769	+0·50
(19)	" "	$1\,c^1\mathfrak{A}$	≏	1 c𝔄	+ 2·975	0·00088	+0·00263	+0·17
(20)	" "	1 c𝔄	≏	1 c𝔅	− 1·275	0·00088	−0·00113	−0·07
(21)	" "	5 c𝔄 + 2 c𝔄 + 2 c𝔅 + 1 c𝔄	≏	1 d𝔄	+ 0·025	0·00087	+0·00002	+0·00
(22)	" "	$5\,c\mathfrak{B} + 2\,c\mathfrak{A} + 1\,c\mathfrak{A} + 1\,c^1\mathfrak{A} + 1\,c\mathfrak{B}$	≏	1 d𝔅	+ 1·900	0·00087	+0·00167	+0·11

Appendix XII.—*continued.*

No.	Date.	Compared	≏	Comparing Standard.	Difference of compared Standard in Divisions.	Value of one Division. No. 4 Balance.	Difference.	
							In Grains.	In Milligrams.
	1870.	*Milligrams, 𝔄 and 𝔅.*						
(23)	April 13			gramme.		grains.		
(24)	„ „	5 m 𝔄 + 5 m 𝔅	≏	1 c 𝔄	+ 4·400	0·00086	+0·00382	+0·25
(25)	„ „	5 m 𝔄 + 5 m 𝔅	≏	1 c 𝔅	+ 2·025	0·00086	+0·00176	+0·15
(26)	„ „	5 m 𝔄	≏	5 m 𝔅	− 3·225	0·00095	−0·00307	−0·20
(27)	„ „	2 m 𝔄 + 2 m 𝔅 + 1 m 𝔄	≏	5 m 𝔄	+ 3·675	0·00095	+0·00350	+0·23
(28)	„ „	2 m 𝔄 + 1 m 𝔄 + 1 m^{1} 𝔄 + 1 m 𝔅	≏	5 m 𝔅	+ 2·075	0·00095	+0·00198	+0·13
(29)	„ „	2 m 𝔄	≏	2 m 𝔅	− 0·550	0·00093	−0·00052	−0·03
(30)	„ 19	1 m 𝔄 + 1 m 𝔅	≏	2 m 𝔅	+ 1·225	0·00093	+0·00115	+0·07
(31)	„ „	1 m^{1} 𝔄	≏	1 m 𝔄	+ 1·975	0·00088	+0·00175	+0·14
(32)	„ „	1 m 𝔄	≏	1 m 𝔅	− 3·700	0·00088	−0·00329	−0·21
(33)	„ „	5 m 𝔄 + 2 m 𝔄 + 2 m 𝔅 + 1 m 𝔄	≏	1 c 𝔄	+ 5·100	0·00089	+0·00457	+0·30
(34)	„ „	5 m 𝔅 + 2 m 𝔅 + 1 m^{1} 𝔄 + 1 m 𝔄 + 1 m 𝔅	≏	1 c 𝔅	+ 4·950	0·00101	+0·00502	+0·32
(35)	„ „	0·5 m 𝔄 + 0·5 m^{1} 𝔄	≏	1 m 𝔄	+ 7·775	0·00092	+0·00715	+0·46
(36)	May 10	0·5 m^{1} 𝔄	≏	0·5 m 𝔄	+ 0·825	0·00087	+0·00072	+0·05
(37)	April 19	0·5 m 𝔅 + 0·5 𝔅^{1}	≏	1 m 𝔅	− 9·475	0·00090	−0·00857	−0·55
		0·5 m 𝔅^{1}	≏	0·5 m 𝔅	+ 4·425	0·00095	+0·00413	+0·27
		Counterpoises, ℭ.						
(38)	April 20	5 d ℭ	≏	5 d 𝔄	− 1·075	0·00094	−0·00100	−0·06
(39)	„ „	2 d ℭ	≏	2 d 𝔄	+ 4·100	0·00090	+0·00372	+0·24
(40)	„ „	1 d ℭ	≏	1 d 𝔄	+ 7·650	0·00084	+0·00649	+0·42
(41)	„ „	1 d^{1} ℭ	≏	1 d^{1} 𝔄	− 0·600	0·00084	−0·00051	−0·03
(42)	„ „	5 c ℭ	≏	5 c 𝔄	+ 1·575	0·00090	+0·00143	+0·09
(43)	„ „	2 c ℭ	≏	2 c 𝔄	+ 6·200	0·00094	+0·00586	+0·38
(44)	„ „	1 c ℭ	≏	1 c 𝔄	+ 2·050	0·00089	+0·00184	+0·12
(45)	„ „	1 c^{1} ℭ	≏	1 c^{1} 𝔄	− 4·150	0·00089	−0·00372	−0·24
(46)	„ 21	5 m ℭ	≏	5 m 𝔄	+ 0·875	0·00095	+0·00083	+0·05
(47)	„ „	2 m ℭ	≏	2 m 𝔄	− 7·000	0·00100	−0·00201	−0·13
(48)	„ „	1 m ℭ	≏	1 m 𝔄	+ 7·475	0·00096	+0·00719	+0·47
(49)	„ 22	1^{1} m ℭ	≏	1^{1} m 𝔄	− 1·375	0·00094	−0·00129	−0·08
(50)	„ „	0·5 m ℭ	≏	0·5 𝔄	+ 1·725	0·00096	+0·00167	+0·19
(51)	„ „	0·5 m^{1} ℭ	≏	0·5^{1} 𝔄	+ 0·925	0·00096	+0·00089	+0·06
(52)	„ „	5 d to ℭ 0·5 m^{1}	≏	5 d to 0·5 m^{1} 𝔄	+21·800	0·00092	+0·02018	+1·31

Results of Comparisons.

Denomination of Metric Standard Weight.	Ascertained Weight.	Mean.	Mean ascertained Error, + or −.	Denomination of Metric Standard Weight.	Ascertained Weight.	Mean.	Mean ascertained Error, + or −.
𝔄.—(*Standards of Reference.*)	mgr.	mgr.	mgr.	𝔄.—(*Standards of Reference*)—cont^{d}.	mgr.	mgr.	mgr.
5 decigrams - -	500·11 500·08	500·10	+0·10	2 milligrams - -	2·18 2·16	2·15	+0·15
2 „ - -	199·84 199·81	199·82	−0·18	1 „ - -	0·95 0·95	0·95	−0·05
1 „ - -	99·75 99·74	99·75	−0·25	1^{1} „ - -	1·09 1·09	1·09	+0·09
1^{1} „ - -	100·11 100·10	100·10	+0·10	0·5 „ - -	0·68	0·68	+0·18
				0·5^{1} „ - -	0·73	0·73	+0·23
5 centigrams - -	50·04 50·02	50·03	+0·03	𝔅.—(*Official Standards.*)			
2 „ - -	19·91 19·86	19·89	−0·11	5 decigrams - -	499·33 499·29	499·30	−0·69
1 „ - -	10·07 10·04	10·06	+0·06	2 „ - -	199·95 199·92	199·94	−0·06
1^{1} „ - -	10·24 10·22	10·23	+0·23	1 „ - -	100·25 100·23	100·24	+0·24
5 milligrams - -	5·05 5·04	5·05	+0·05	1^{1} „ - -	100·24	10·24	+0·24

Appendix XII.—*continued.*

Denomination of Metric Standard Weight.	Ascertained Weight.	Mean.	Mean ascertained Error, + or −.	Denomination of Metric Standard Weight.	Ascertained Weight.	Mean.	Mean ascertained Error, + or −.
𝔅.—*Official Standards*)—cont^{d}.	mgr.	mgr.	mgr.	ℭ.—(*Counterpoises.*)	mgr.	mgr.	mgr.
5 centigrams - -	50·04 50·02	50·03	+0·03	5 decigrams - -	500·03	—	+0·03
				2 „ - -	200·06	—	+0·06
2 „ - -	19·72 19·66	19·69	−0·31	1 „ - -	100·17	—	+0·17
				1^{1} „ - -	100·07	—	+0·07
1 „ - -	10·17 10·15	10·13	+0·13	5 centigrams - -	50·12	—	+0·12
1^{1} „ - -	10·34	10·38	+0·38	2 „ - -	20·27	—	+0·27
5 milligrams - -	5·25 5·24	5·25	+0·25	1 „ - -	10·18	—	+0·18
				1^{1} „ - -	9·99	—	−0·01
2 „ - -	2·18 2·19	2·19	+0·19	5 milligrams - -	5·10	—	+0·10
				2 „ - -	2·02	—	+0·02
1 „ - -	1·16 1·16	1·16	+0·16	1 „ - -	1·48	—	+0·42
1^{1} „ - -	1·17	1·17	+0·17	1^{1} „ - -	1·01	—	+0·01
0·5 „ - -	0·33	0·33	−0·17	0·5 „ - -	0·79	—	+0·29
0·5^{1} „ - -	0·60	0·60	+0·10	0·5^{1} „ - -	0·79	—	+0·29

SERIES of TEN NEW WEIGHTS of 1 KILOGRAM each, Nos. 1 to 10.

Description of the new series of weights of 1 kilogram.

Before the verification of the larger metric weights from 2 kilog. to 20 kilog. could be completed and their precise errors from the standards determined, it was necessary that the series of ten new weights of one kilogram each, which had been ordered from Mr. Oertling on 24th July 1869, and were delivered to this Department on 21st Sept. 1869, should be verified, and the standard weight of each ascertained.

It was agreed at the 18th meeting of the Standards Commission on 21st July 1869, that such a series of standard units should be used as auxiliary standards in the verification of the larger official standard weights.

These weights are of Baily's metal, not gilt, and are similar in form and construction to the new set of avoirdupois standards, and the series of fourteen weights of one Imperial pound each, referred to in App. V., p. 66.

Mode c their v ficatior

The comparison of these kilogram weights has been made by using the new balance constructed for the purpose by Mr. Oertling, in pursuance of directions given him on 8th December 1869.

The cost of this new balance is 30*l.* It will be designated as balance No. 5.

The verification of these new kilogram weights, which are designated as 𝔎 No. 1 to No. 10, has been based on the gilt gun-metal kilogram 𝔎, the two brass kilograms 𝔐 and ℭ having been used to check the weighings. The 𝔅 set of small metric weights was used for balance weights.

COMPARISON of TEN BRONZE KILOGRAMS, 𝔎 No. 1 to No. 10.

No. of Comparison.	Date.	Compared Standard.	Comparing Standard.	Value of One Division.	Difference of compared Standard.	
					In Divisions of Balance No. 5.	In Milligrams.
	1870.			mgr.	mgr.	mgr.
(1)	May 13	Bronze 𝔎 No. 1	≏ Brass ℭ + 16·791 mgr. -	0·078	− 7·87	−0·61
(2)	„ 14	𝔎 No. 1	≏ Gilt 𝔎 + 5·247 mgr. -	0·061	− 8·25	−0·51
(3)	„ 10	𝔎 No. 1	≏ Brass 𝔐 + 11·295 mgr. -	0·114	+20·87	+2·38
(4)	„ 11	𝔎 No. 2	≏ 𝔎 - - - -	0·096	+ 5·45	+0·53
(5)	„ 12	𝔎 No. 2 + 3·356 mgr. 𝔟	≏ 𝔎 No. 1 - - -	0·080	−14·52	−1·16
(6)	„ „	𝔎 No. 3	≏ 𝔎 + 3·356 mgr. - -	0·058	+25·70	+1·49
(7)	„ 13	𝔎 No. 3	≏ 𝔎 - - - -	0·069	−10·27	−0·71
(8)	„ 16	𝔎 No. 4 + 13·482 mgr. 𝔟	≏ 𝔎 No. 1 - - -	0·096	+29·25	+1·50
(9)	„ „	𝔎 No. 4 + 17·566 mgr. 𝔟	≏ 𝔎 No. 1 - - -	0·123	− 7·49	−0·92
(10)	„ 19	𝔎 No. 5 + 5·247 mgr. 𝔟	≏ 𝔎 - - - -	0·107	− 9·37	−1·01
(11)	„ 26	𝔎 No. 5 + 8·597 mgr. 𝔟	≏ 𝔎 No. 1 - - -	0·090	−32·44	−2·92
(12)	„ 20	𝔎 No. 6	≏ 𝔎 + 4·174 mgr. - -	0·072	−23·25	−1·67
(13)	„ „	𝔎 No. 6	≏ 𝔎 No. 1 + 2·187 mgr. -	0·092	−42·37	−3·88
(14)	„ 21	𝔎 No. 7 + 5·247 mgr. 𝔟	≏ 𝔎 - - - -	0·082	−18·94	−1·45
(15)	„ 26	𝔎 No. 7 + 10·132 mgr. 𝔟	≏ 𝔎 No. 1 - - -	0·078	−25·00	−1·94
(16)	„ 21	𝔎 No. 8 + 1·163 mgr. 𝔟	≏ 𝔎 - - - -	0·102	−33·37	−3·38
(17)	„ 27	𝔎 No. 8 + 6·410 mgr. 𝔟	≏ 𝔎 No. 1 - - -	0·116	− 0·75	−0·09
(18)	„ „	𝔎 No. 9	≏ 𝔎 No. 1 - - -	0·086	−31·25	−2·70
(19)	„ 23	𝔎 No. 9	≏ 𝔎 + 2·187 mgr. - -	0·074	−17·00	−1·26
(20)	„ 27	𝔎 No. 10 + 5·247 mgr. 𝔟	≏ 𝔎 No. 1 - - -	0·088	−26·75	−2·36
(21)	„ „	𝔎 No. 10 + 5·247 mgr. 𝔟	≏ 𝔎 - - - -	0·151	+13·25	+2·01

Appendix XII.—*continued.*

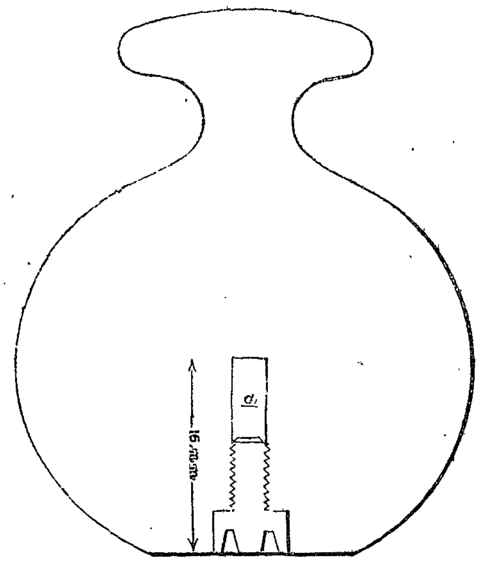
RESULTS of COMPARISONS.

Determination of their standard weight.

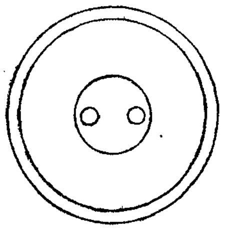
——	Denomination of Standard.	Ascertained Weight.	Mean.	Mean ascertained Error.
		grammes.	grammes.	grammes.
(1)	𝔎 No. 1 =	1000·01628	1000·01563	+0·01563
(2)	𝔎 No. 1 =	1000·01508		
(3)	𝔎 No. 1 =	1000·01554		
(4)	𝔎 No. 2 =	1000·01086	1000·01098	+0·01098
(5)	𝔎 No. 2 =	1000·01111		
(6)	𝔎 No. 3 =	1000·01518	1000·01505	+0·01505
(7)	𝔎 No. 3 =	1000·01492		
(8)	𝔎 No. 4 =	1000·00360	1000·00023	+0·00023
(9)	𝔎 No. 4 =	999·99687		
(10)	𝔎 No. 5 =	1000·00409	1000·00410	+0·00410
(11)	𝔎 No. 5 =	1000·00412		
(12)	𝔎 No. 6 =	1000·01451	1000·01422	+0·01422
(13)	𝔎 No. 6 =	1000·01394		
(14)	𝔎 No. 7 =	1000·00364	1000·00360	+0·00360
(15)	𝔎 No. 7 =	1000·00356		
(16)	𝔎 No. 8 =	1000·00579	1000·00746	+0·00746
(17)	𝔎 No. 8 =	1000·00914		
(18)	𝔎 No. 9 =	1000·01297	1000·01211	+0·01211
(19)	𝔎 No. 9 =	1000·01126		
(20)	𝔎 No. 10 =	1000·00803	1000·00757	+0·00757
(21)	𝔎 No. 10 =	1000·00711		

Density of 𝔎 No. 1.

The density of only one of these new standard kilograms, 𝔎 No. 1, has been ascertained, by weighing it in water. The following is the exact size and form of 𝔎 No. 1. The small cylindrical cavity is marked as *a*.



New 1 Kilogram Weight 𝔎 No. 1. Actual size.
Height = 74 mm.
Greatest diameter = 61 mm.
Diameter of knob = 34 mm.



Bottom of 1 Kilog. Weight, 30 mm. diameter.

WEIGHING in WATER of 𝔎 No. 1.

Ascertained Weight of 𝔎 No. 1 in ordinary Air = 1000·01563 *grammes, or* 15432·58995 *grains.*

Date.	Weighings.	Difference in Divisions.	Value of One Division of Balance.	Difference in Grains.
1869.		div.	grains.	grains.
Nov. 6	𝔎 No. 1, in water ≏ Bronze 12,800 grains + 600, 100, 6, 1 gilt grains (or 13506·97710 grains).	−15·666	0·03877	0·60740

Appendix XII.—*continued.*

		in.	grains.
Hence, weight of 1 kilogram 𝔎 No. 1 in air,	$t=58^{\circ}\cdot4$,	$b=29\cdot660$	=15432·58995
„ „ in water,	$t=57\cdot8$ -	-	=13506·36970
Difference		-	= 1926·22025
Add weight of air displaced by 13506·36970 gr. of bronze			= 2·00638
∴ Weight of water displaced by 𝔎 No. 1		-	= 1928·22663

Log. of weight of water displaced - - - = 3·2851581

Add log. of W_t - - - - - = +0·0003270

3·2854851

Deduct log. $(1+eB_t)$ - - - - - = −0·0003176

∴ log. v 𝔎 No. 1 - - - - = 3·2851675

Deduct from log. weight in air of 𝔎 No. 1 - - = 4·1884387

∴ log. Δ 𝔎 No. 1 - - - - = 0·9032712

Whence Δ 𝔎 No. 1 - - - - - = 8·0033

PART 2.—Verification of Official Metric Standard Measures of Length.

Contents.

	Page
All the metric standards denoted by Old English letters -	180
List of official metric standards of length - - -	„
Verification of metre 𝔖𝔖 marked on the bar SS - -	181
Relative expansion of platinum and bronze bars -	„
Comparisons of metre 𝔖𝔖 with ℜ𝔖𝔏𝔐 - -	„
Mode of these comparisons - - - -	„
Causes of differences in the results - - -	„
From temperatures, as noted by the thermometers -	182
Rate of conduction of heat in metallic bars -	„
From expansion of the bronze and platinum bars -	„
M. Fizeau's determination of expansion, based on the length of a wave of light - - - -	„
Description of his apparatus - - - -	„
Altered corrections from latest determinations of rates of expansion - - - - - -	„
Results of these comparisons of metre 𝔖𝔖 - -	183
Description of the two platinum metres of the Royal Society, ℜ𝔖𝔏𝔐 and ℜ𝔖ℭ𝔐 - - -	184
Comparison of these two platinum metres with each other	„
Former comparisons of these two standard metres -	185
Summary of comparisons of ℜ𝔖𝔏𝔐 and ℜ𝔖ℭ𝔐 -	„
Standard length of metre 𝔖𝔖 - - - -	„
Comparison of the metre with the yard marked upon SS -	„
Consequent equivalent of the metre in Imperial measure -	„
Effect of difference of standard temperature on the stated equivalent - - - - - - -	186
Different *commercial* equivalent of the metre - -	„
Verification of decimetres on 𝔖𝔖 - - -	„
New microscope required for centimetres - - -	187
Description of new double microscope - - -	„
Magnifying power of the microscopes - - -	„
Improved method of illumination - - -	„
Verification of micrometers Nos. 5 and 6 of new double microscope - - - - - -	„
Decimal table of values of the division of micrometers Nos. 5 and 6 - - - - - -	189
Verification of centimetres of 𝔖𝔖 - - -	„
Verification of millimetres of 𝔖𝔖 - - -	190

PART II.—VERIFICATION OF THE OFFICIAL STANDARD METRIC MEASURES OF LENGTH.

All metric standards denoted by Old English letters.

In order more readily to distinguish the standard weights and measures of the Metric system from those of the Imperial system, in describing the several operations with them, the method adopted by Professor Miller has been followed, and the Metric standards are always denoted by Old English letters, whilst the Imperial standards are denoted by Roman letters. The two standard bars SS, and CS, upon which measures of both systems are marked, will be expressed by Roman or Old English letters, according as the Imperial or Metric measures are referred to.

List of official metric standards of length.

The following is a list of the official standards of length of the Metric system to be verified in the Standards Department for official use.

1. The metre 𝔖𝔖 marked on the bronze bar SS, which has been already described at p. 34 of the Appendix to the Second Report of the Standards Commission. The length of this metre was laid down from the platinum line standard metre of the Royal Society, adding 0·01759 mm., the deficiency of this standard metre, as originally determined by M. Arago. The metre is divided into decimetres, the last decimetre into centimetres, and an additional centimetre into millimetres. This is intended to be the standard metre for scientific purposes, the divisions being so finely marked that they must be read under the microscopes.

2. The metre ℭ𝔖 marked on the bronze bar CS, described at p. 104 of App. VII. This is divided throughout into decimetres, centimetres, and millimetres, and is intended as the Commercial Standard Metre, being read with a moveable eyepiece and vernier.

3. The brass metre 𝔗 made by Deleuil, and forming part of the set of Metric standards purchased from Messrs. Tylor.

This is a flat brass scale one metre in length, being consequently an end measure, or mesure à bouts; the bar is 0·6 mm. thick, and 3 mm. broad. It is engraved "Mètre "Etalon. Glace Fondante, Deleuil a Paris." The whole length of the metre is divided into centimetres, every tenth centimetre being numbered 10, &c. to 90 to mark the decimetre distances. The centimetres 0–10, and 90–100, at the extremities of the scale, are also each numbered, and are subdivided into millimetres.

4. The standard metre à bouts ℭ𝔐, recently ordered to be constructed by Messrs. Troughton and Simms.

5. The graduated scale of a decimetre 𝔖, marked upon the slider of the bronze bar S, has already been described in Paper XIX.–i., p. 1.

Appendix XII.—*continued.*

VERIFICATION of the STANDARD LENGTH of the METRE marked upon SS.

Verification of metre marked on SS.

The determination of the standard length of the metre marked upon the new scientific standard bar 𝕾𝕾 of Baily's metal, has been effected by comparing it with the two platinum metres of the Royal Society. This comparison has been made in a similar manner to that adopted by Capt. Kater in 1818, when he compared these two platinum standards with the Shuckburgh scale, in order to determine the equivalent of the metre in Imperial measure. The details of his comparison have been shown in the concluding part of App. IX., p. 152.

Relative expansion of platinum and bronze bars.

Bas du Syst. Met., Vol. iii., p. 440.

For reducing the observations to the standard temperature, the coefficient of linear expansion of the two platinum bars, which are considered to be of similar metal to the Metre des Archives, has been taken according to Borda's determination, this having been hitherto accepted in France for comparisons of the platinum metres constructed at that period. The French Commission of Weights and Measures found the expansion of a platinum bar to be the $\frac{1{\cdot}713}{200000}$th part, or 0·00000856, for 1° C. = 0·00000476 for 1° F. This is equivalent to an expansion of 0·00476 mm. for 1° F. in a platinum metre.

The coefficient of linear expansion of bars of Baily's metal, or bronze bars, has been taken from the accepted result of Mr. Sheepshanks' observations at ordinary temperatures, viz.: at 0·00000947 for 1° Fahr., equivalent, in a bronze metre, to 0·00947 mm. for 1° Fahr.

In like manner the coefficient of linear expansion of brass has been taken at 0·00000956 for 1° F. or 0·00956 mm. in a brass metre for 1° F.

The consequent relative amounts of expansion in metres composed of these three metals, for 30° F., being the difference between the French standard temperature of 32° Fahr. and the English standard temperature of 62° Fahr., is as follows:—

Metre.		Expansions for 30° F. mm.		in.
Platinum - -	-	0·14280	or	0·005622
Bronze (Baily's metal)	-	0·28410	„	0·011188
Brass - - -	-	0·28698	„	0·011298

COMPARISON of METRE 𝕾𝕾 with 𝕽𝕾𝕷𝕸.

Comparisons of 𝕾𝕾 with 𝕽𝕾𝕷𝕸.

The following comparisons have been made of the length of the metre 𝕾𝕾 with the metre marked on the platinum line standard of the Royal Society, 𝕽𝕾𝕷𝕸. Thirty-six readings of the micrometer were noted in each case. Decimal tables of the metric values of one division of each of the four micrometers No. 1 to No. 4 have already been given at page 120 of App. VII.

No.	Date.	Mean Temperature, Fahr.	Result of Observations.	Corrections for Temperature reduced to 32° Fahr.			Net Result.
				Expansion of Bronze Metre.	Expansion of Platinum Metre.	Net Correction.	
	1868.	°	mm.	mm.	mm.	mm.	mm.
(1)	Jan. 29	50·75	𝕾𝕾 = 𝕽𝕾𝕷𝕸 + 0·11391	0·17756	0·08925	−0·08831	+0·02560
(2)	„ 30	50·15	„ = „ + 0·10702	0·17188	0·08639	−0·08548	+0·02154
(3)	Feb. 1	50·71	„ = „ + 0·11440	0·17718	0·08906	−0·08812	+0·02628
(4)	„ 2	49·80	„ = „ + 0·10543	0·16856	0·08473	−0·08383	+0·02160
(5)	„ 19	32·00	„ = „ + 0·01892	—	—	—	+0·01893
(6)	„ 22	51·00	„ = „ + 0·10490	0·17993	0·09044	−0·08949	+0·01541
(7)	„ 23	33·75	„ = „ + 0·03294	0·01657	0·00833	−0·00824	+0·02470
(8)	Mar. 2	32·00	„ = „ + 0·02252	—	—	—	+0·02252

Mean of the six comparisons, corrected from ordinary temperatures, 𝕾𝕾 = 𝕽𝕾𝕷𝕸 - - + 0·02257

Mean of the two comparisons at the temperature of melting ice „ = „ - - + 0·02072

Difference of the mean results of the two sets of comparisons 𝕾𝕾 = 𝕽𝕾𝕷𝕸 - - 0·00185

Mode of these comparisons.

In the first part of these comparisons at ordinary temperatures, the platinum line metre, which is only ¼ inch in thickness, was supported upon one of the steel line standard bars resting upon the ordinary rollers, steel having nearly the same coefficient of expansion as platinum. The upper surface of this steel bar, and the under surface of the platinum bar, had both been previously tested by trying them upon the gun-metal plane which had been used by Mr. Sheepshanks, and has recently been transferred to the Standards Department; both surfaces were found to be accurately level. At the suggestion of Professor Miller, an attempt was made to interpose several of Mordan's pencil leads between the platinum bar and the steel bar, to act as rollers, but the experiment was unsuccessful.

In the two latter comparisons at ordinary temperatures (6), (7), the platinum bar was placed upon the rollers, the steel bar being removed.

The comparisons at the temperature of melting ice, were made by removing the ordinary supporting plane of the comparing apparatus, and substituting a strong cast-iron trough. For these comparisons, the steel bar was not placed under the platinum bar, which was supported only by the rollers. Pounded ice was placed in the box and around and above the measuring bars; protection from the pressure of the ice was afforded by a wire shield placed immediately over the bars. In each case the bars were placed in position, together with the ice, on the evening before the comparisons were made, fresh ice being added next morning. For the comparison (7) on 23rd February, broken, not pounded, ice was used, and the mean temperature did not fall below 33·75° Fahr., as noted by the thermometers. It will be seen that the result of the last comparison on 2nd March agrees with the mean result of the comparisons in ordinary air. The greatest precautions were taken during comparisons (5) and (8) to secure the most accurate determination, the metre having been in ice 20 hours before the comparisons were made, and the wire shield prevented any pressure upon the ice and consequent flexure or disturbance from level.

Causes of differences in the results:

The differences exhibited in the results of the several comparisons at ordinary temperatures, without reference to errors of observation, may be attributed—

1st. To the precise temperature of the bars not having been ascertained;

2nd. To the precise rate of expansion of the bronze and platinum bars not having been ascertained.

Appendix XII.—*continued.*

From temperatures, as noted by the thermometers.

The temperature of the two bars was determined from the mean of two thermometers placed upon them. They were selected as being of the most convenient form for the comparison of standards of length, having the bulb bent at right angles to the stem. One of these thermometers belongs to the 10-feet Cape of Good Hope standard, the other to the East India 6-inch standard. But these thermometers had no certificate of verification, and they disagreed between themselves to the extent of nearly 0·5° F. when approaching the freezing point. Upon comparison with a standard thermometer verified at Kew, their mean reading at 50° C. was 0·4° less than the standard. Unfortunately the thermometer belonging to the East India standard bar was accidentally broken after it had been used for the comparisons, and thus its actual error could not be ascertained.

Both the bronze bar and the platinum bar are flat bars, without any well or hole for inserting the bulbs of the thermometers, and thus the actual temperature of the bar, as determined by a thermometer placed upon its surface, cannot be depended on as absolutely accurate, even assuming the thermometer itself to register the temperature correctly.

Rate of conduction of heat in metallic bars.

For ascertaining the temperature of the metallic bars, the mean observed temperature was taken in each comparison, that is to say, the mean between the temperature noted at the beginning and at the end of the observations. But part of the discordance of the several comparisons may be attributable to the difference in the rate at which heat is conducted in the several metals, as well as to differences in the specific heats of the two bars compared.

It may be desirable that some experiments be made for the purpose of determining how far these causes may interfere with the accurate comparison of standard measures of length, in order that precautions be taken to guard against the results being affected by them. It is almost impossible to prevent a slight increase of temperature in the bars during observation, especially from the necessarily near proximity of the observer.

From expansion of the bronze and platinum bars.

Clarke, p. 217.

As to the relative rates of expansion of the bronze and platinum bars, it is to be observed that in the latest experiments on the expansion of metals made by Captain Clarke at Southampton, he determined the expansion of bronze (Baily's metal) to be somewhat greater than the result of Mr. Sheepshanks' observations, viz. :—

Mean result of 50 comparisons, at various temperatures from 38·69° to 99·13° F.=0·0000098870
Mean result of 27 comparisons, from 54·18° to 96·19° - - - =0·0000098277
Mean =0·0000098574

Captain Clarke's observations appear to have been made with the greatest precautions for ensuring accuracy, and with a series of thermometers carefully verified by himself for the purpose.

M. Fizeau determin tion of expansion based on the lengt of a wave light.

The most recent determination of the expansion of the old platinum bars of which the earlier metres was composed, is that of M. Fizeau, being the results of his observations made for the International Metric Commission at Paris, of which he is a member. These observations were made by means of an entirely new description of apparatus constructed under his directions.

M. Fizeau's researches upon the dilatation by heat of solid bodies, particularly his paper, "Memoires sur la dilatation des corps solides par la chaleur," are mentioned in the Proceedings of the Royal Society of 30th November 1866, when as a testimony of their value the Rumford gold medal of the Royal Society was awarded to him.

Descript of his apparatus.

The principles upon which M. Fizeau's apparatus is constructed, and its mode of construction, are thus described in the Royal Society's Minutes of Proceedings :—

"In M. Fizeau's observations he has availed himself of the possibility of forming Newton's rings with the monochromatic sodium light, when one of the interfering rays is 52,205 waves in advance of the other, a fact which, conjointly with M. Foucault, he announced in 1849. Using the length of a wave of sodium light=0·0005888 millimetre (0·00002318 inch) as the standard of measure, the position of a ring being observable to within $\frac{1}{10}$ of the distance between two consecutive rings, the variation of the distance between two surfaces producing the Newton's rings can be measured within $\frac{1}{33967}$ millimetre (0·00002944 mm. or 0·0001159 inch).

"A plate of the substance to be experimented on (let us suppose it to be fluor) usually from 10 to 15 millimetres thick, bounded by parallel plane surfaces, rests upon the platform of a metal tripod (the metal was steel in the earlier observations, platinum with $\frac{1}{10}$ of iridium in the later). The feet of the tripod are screws of equal lengths terminating above in obtuse points. On these points, at a distance of about $\frac{1}{50}$ millimetre above the upper surface of the fluor, rests a plate of glass. By counting the number of rings or bands that pass over a mark on the upper surface of the fluor during a given change of temperature, the corresponding variation of distance between the lower surface of the glass and the upper surface of the fluor is given, and the expansion of the metal being known by a similar process, the expansion of the fluor is found.

The experiments of M. Fizeau with this apparatus were made upon a piece of the metal of which the original platinum metres were made, some of this metal having been preserved at the Palais des Archives. The results of these observations were deemed to show conclusively that the coefficient of expansion of this platinum determined by Borda to be 0·00000856 for 1° C., should be 0·00000865, equal to 0·000004805 for 1° F.

Altered correcti from lat determi tions of rates of pansion.

The following table shows the corrections to be made in the preceding comparisons, according to these more recent determinations of the rate of expansion of bronze and platinum bars :—

No.	*t.*	Corrections for Temperature, reduced to 32° F.			Net Result.
		Expansion of Bronze Metre at 0·00000985 for 1° F.	Expansion of Platinum Metre at 0·000004805 for 1° F.	Net Correction.	
	° F.	mm.	mm.		
(1)	50·75	0·18468	0·09010	−0·09458	+0·01934
(2)	50·15	0·17877	0·08721	−0·09156	+0·01546
(3)	50·71	0·18429	0·08990	−0·09439	+0·02001
(4)	49·80	0·17533	0·08553	−0·08980	+0·01563
(6)	51·00	0·18715	0·09130	−0·09585	+0·00905
(7)	33·75	0·01724	0·00841	−0·00883	+0·02411
			Mean - - - -		+0·01893

Thus agreeing precisely with the result of comparison (5) at the temperature of melting ice.

Results of these comparisons of §§.

Under all these circumstances, and considering the great care with which the two comparisons (5) and (8) were taken at the temperature of melting ice, the mean results of these comparisons may be relied on as a sufficiently accurate determination of the length of the metre on the bronze bar, as compared with the platinum standard.

Appendix XII.—*continued.*

The details of these two comparisons are as follows:—

(5) 19*th February* 1869.

Readings of Micrometer No. 1.		𝔖𝔖 −.		Readings of Micrometer No. 4.		𝔖𝔖 +.		Mean Difference of 𝔖𝔖.
𝔖𝔖.	ℜ𝔖𝔏𝔐.			𝔖𝔖.	ℜ𝔖𝔏𝔐.			
div.	div.	div.	div.	div.	div.	div.	div.	div.
50	122			94	191			
50	121			93	191			
49	121			92	190			
149	364	215	71·6	279	572	293	97·6	+26·0
43	131			89	206			
42	133			91	204			
43	133			92	202			
128	397	269	89·6	272	612	340	113·3	+23·6
48	130			97	205			
48	132			100	206			
47	130			98	205			
143	392	249	83·0	295	616	321	107·0	+24·0
			244·3				318·0	+73·6
			81·4				106·0	+24·5

			mm.
Excess of 𝔖𝔖	106·0 div. of micrometer No. 4	=	+0·08504
"	81·4 No. 1	=	+0·06612
∴ 𝔖𝔖 = ℜ𝔖𝔏𝔐	+24·5 div.	=	+0·01892

(8) 2*nd March* 1869.

Readings of Micrometer No. 1.		𝔖𝔖 +.		Readings of Micrometer No. 4.		𝔖𝔖 −.		Mean Difference of 𝔖𝔖.
𝔖𝔖.	ℜ𝔖𝔏𝔐.			𝔖𝔖.	ℜ𝔖𝔏𝔐.			
div.	div.	div.	div.	div.	div.	div.	div.	div.
327	68			229	2			
327	70			228	1			
328	71			231	1			
982	209	773	257·6	688	4	684	228·0	+29·6
325	71			226	2			
326	72			226	4			
325	72			227	3			
976	215	761	253·6	679	9	670	223·3	+30·3
330	74			231	1			
329	74			229	2			
330	74			230	3			
989	222	767	255·6	690	6	684	228·0	+27·6
			766·0				679·3	+87·6
			255·6				226·4	+29·2

Appendix XII.—*continued.*

			mm.
Excess of 𝔖𝔖	= 255·6 div. of micrometer No. 1	=	0·20843
„ ℜ𝔖𝔏𝔐	= 226·4 „ No. 4	=	0·18591
∴ Bronze metre = Platinum metre	+ 29·2 div.	=	+ 0·02252
(5) „ „	+ 24·5	=	+ 0·01892
∴ 𝔖𝔖 = ℜ𝔖𝔏𝔐			+ 0·02072
Deduct ascertained error of ℜ𝔖𝔏𝔐 in relation to the primary standard metre		-	— 0·01759
Ascertained error of 𝔖𝔖 - - - -		-	+ 0·00313

∴ The official standard metre 𝔖𝔖, at the temperature of melting ice, is thus found to be in excess of the primary Metre des Archives, 0·00313 mm. or 𝔖𝔖 = 1·00000313 metre.

Description of the two platinum metres of the Royal Society.

No comparison has been made between the official bronze metre and the *metre à bouts* of the Royal Society designated as ℜ𝔖𝔈𝔐. It was considered sufficient to compare the two platinum metres, the line standard and the end standard, for the purpose of ascertaining any difference in their length.

In order to show the method of comparison adopted, and the difficulties of obtaining any accurate result with the *metre à bouts,* it may be desirable to give a brief description of these two platinum standard metres.

Figure 1. Platinum *metre à traits,* ℜ𝔖𝔏𝔐, engraved on the under side "Royal Society 45;" there are no letters engraved on the upper side shown in the sketch, upon which the defining lines are marked.

Figs. 2, 3. Platinum *metre à bouts,* ℜ𝔖𝔈𝔐, engraved on one side (Fig. 2) METRE, and on the other side (*Fig. 3*) "FORTIN À PARIS, Royal Society 44." The irregular and indented edges of the extremities of this metre are shown as accurately as may be at *a, b,* and a^1, b^1.

Fig. 1.

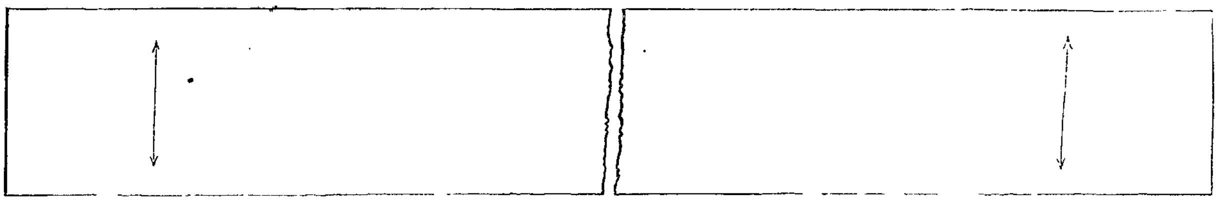


Fig. 2.

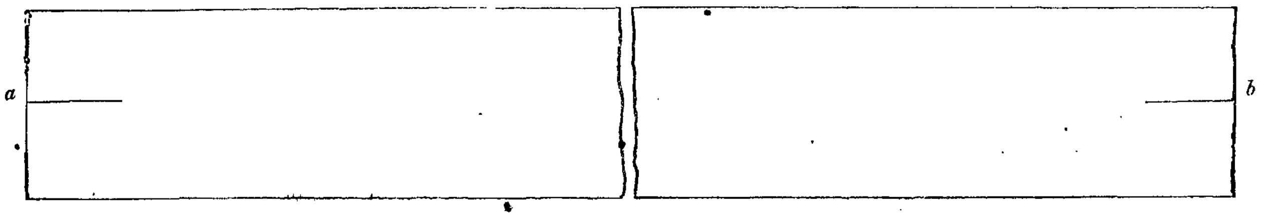
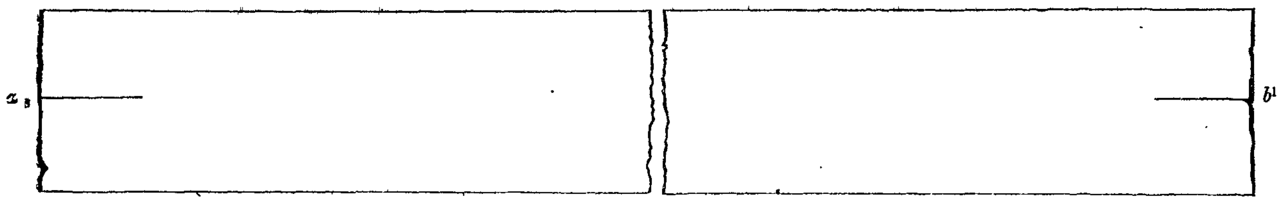


Fig. 3.



The following are the dimensions of these two platinum metres :—

			English inches, or	millimetres.
Metre à traits, ℜ𝔖𝔏𝔐	Length	= 41	English inches, or	1041·38118 millimetres.
	Breadth	= 1·	„	25·39954 „
	Thickness	= 0·211	„	5·35930 „
Metre à bouts, ℜ𝔖𝔈𝔐	Length	= 39·37	„	„
	Breadth	= 1·00	„	25·39954 „
	Thickness	= 0·287	„	7·28967 „

Comparison of the two platinum metres with each other.

In the comparison of the platinum *mètre à bouts* with the Shuckburgh scale in 1818, Capt. Kater used rectangular contact pieces somewhat similar to that employed in the Standards Department. But at the present time, in addition to the difficulty arising from the indented and irregular edges of the extremities of ℜ𝔖𝔈𝔐, there is also a raised burr, which rendered it impracticable to adjust accurately to the ends of this platinum standard bar, the rectangular contact apparatus constructed for the spherical ends of standard measures à bouts. The only practicable method of measurement was found to be to adjust the cross lines of the microscope as nearly as possible to the points marked *a, b,* and a^1, b^1, in the above sketch. The exact points to which the cross lines were adjusted, were those at which the edge was met by the ends of a short longitudinal line cut upon each extremity of the upper and under surfaces of the bar in the middle of its breadth, as shown in figs. 2 and 3.

Appendix XII.—*continued.*

COMPARISON OF 𝕽𝕾𝕰𝕸 with 𝕽𝕾𝕷𝕸.

Date.	Mean Temp. Fahr.	Number of Readings.	Result of Observations.	Remarks.
1869.	°		mm.	
Feb. 9 -	54·0	36	𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 + 0·021055	Surface engraved, "metre" uppermost.
„ 10 -	56·9	36	𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 + 0·032479	„ „ "Fortin à Paris" uppermost.
			Mean of 72 readings, 𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 + 0·026767	

It was thought, however, that it would be more satisfactory to measure the length of 𝕽𝕾𝕰𝕸 from the middle of each rectangular end, and that for the more accurate comparison of all standard measures à bouts with rectangular terminations, contact pieces with spherical ends should be added to the comparing apparatus of the Department, thus enabling any difficulty to be overcome in the comparison of standard measures of length, like the standard metre à bouts 𝕽𝕾𝕰𝕸, with indented or irregular edges. The two new contact pieces with spherical ends, which have been already described in App. VII., p. 100, and shown as *c* and *d* in Fig. 4, Plate 2, were consequently furnished by Messrs. Troughton and Simms, and were used in the following comparisons. These spherical ends have been brought into contact with the ends of 𝕽𝕾𝕰𝕸, within the indented and raised edges, and where the surface appears uninjured, and by this means the exact length of the platinum metre à bouts as originally constructed can be ascertained.

The distance between the defining lines of these two contact pieces when placed together, has been ascertained to be 3112·7 divisions of micrometer No. 2 = 2·520469 mm., and this has been deducted in the stated results of the following comparisons:—

Further comparison of 𝕽𝕾𝕰𝕸 with 𝕽𝕾𝕷𝕸.

Date.	Temp. Fahr.	Number of Reading.	Result of Comparisons.
1869.			mm.
Oct. 6 -	62°·4	36	𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 + 0·00837

Former comparisons of the two platinum metres.

According to the original verification by M. Arago at Paris, of these two platinum metres, as stated by Capt. Kater, 𝕽𝕾𝕷𝕸 was 0·01759 mm. less than the metre des Archives, whilst it would appear that 𝕽𝕾𝕰𝕸 was taken to be exactly equal to the primary standard; whence 𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 + 0·01759 mm.

By referring to Capt. Kater's account of his comparison of the platinum metres of the Royal Society, it may be seen that he found the difference in length of these two standards to be as follows, in inches of Shuckburgh's scale:—

𝕽𝕾𝕰𝕸 = 39·37082 inches, "metre" uppermost.
„ = 39·37081 „ "Fortin" „

Mean = 39·37081 „
𝕽𝕾𝕷𝕸 = 39·37007 „

∴ 𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 + 0·00074 inch, or + 0·01881 mm.

A somewhat different relative length is now assigned to 𝕽𝕾𝕰𝕸, but from its imperfections already alluded to, as well as from the further defect of the surface of this platinum bar having been found on being tested with the gun-metal plane to be far from a true plane, full dependence can hardly be placed on the accuracy of a comparison with this metre à bouts.

The two platinum metres of the Royal Society were also compared by Mr. Baily, in 1835, the details of the comparisons being given in the Memoirs of the Astronomical Society for 1836, pp. 88 and 132–8. For the measurement of the metre à bouts Mr. Baily used two spherical contact pieces applied in a *vertical* position to the middle of the two ends of the metre where the surface did not project. The mean results of his comparisons were as follows, in inches of the Astronomical Society's scale:—

𝕽𝕾𝕰𝕸 = 39·369451 inches, "metre" uppermost.
„ = 39·369298 „ "Fortin" „

Mean = 39·369375 „
𝕽𝕾𝕷𝕸 = 39·368985 „

∴ 𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 + 0·000370 inch = + 0·00940 mm.

Baily's observations were made partly in the summer and partly in the winter of 1835, and at ordinary temperatures of the air, those in the winter having been taken when the thermometer was *below* freezing point. He assumed 0·00000505 and 0·00001048 as the rates of expansion of platinum and brass respectively, and made his reductions accordingly. If he had taken the same rates of expansion as Kater, viz., 0·00000476 and 0·0000101, the result would have been 𝕽𝕾𝕷𝕸 = 39·369335 in., or 0·000350 in. more.

Summary of comparisons of 𝕽𝕾𝕰𝕸 and 𝕽𝕾𝕷𝕸.

The following is a summary of the several before-mentioned comparisons made with the two platinum metres of the Royal Society:—

		mm.
In 1818, by M. Arago	𝕽𝕾𝕷𝕸 = Metre des Archives	− 0·01759
	𝕽𝕾𝕰𝕸 = „ „	
	∴ 𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 -	+ 0·01759
„ 1818, by Capt. Kater	𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 -	+ 0·01881
„ 1835, by Mr. Baily	𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 -	+ 0·00940
„ 1869, at Standards Office	𝕽𝕾𝕰𝕸 = 𝕽𝕾𝕷𝕸 -	+ 0·00837

Standard length of the metre 𝕾𝕾.

From the difficulty thus found in making accurate comparisons with the platinum metre à bouts 𝕽𝕾𝕰𝕸, it has been considered that the verification of the metre marked on 𝕾𝕾 should rest on its comparison with the platinum line standard 𝕽𝕾𝕷𝕸 only, and that 𝕾𝕾 be consequently determined as equal to 1·00000313 metre, at 32° Fahr., or the temperature of melting ice.

Comparison of the metre with the yard marked upon 𝕾𝕾.

Upon the completion of the verification of the standard yard and its several subdivisions marked upon 𝕾𝕾, and the determination of the standard length of each measure in terms of the Imperial standard, as well as of the verification of the metre and its subdivisions marked upon the same bar, by comparison with the platinum standards of the Royal Society, from which the legal Imperial equivalent of the metre was determined, according to Captain Kater's observations in 1818, it may be a matter of some importance to compare the length of the standard metre with its equivalent length in Imperial measure, thus marked upon the same bar, and to ascertain how far this result agrees with the existing legal determination of the length of the metre in terms of the Imperial standard yard, viz., 39·37079 inches.

Consequent equivalent of the metre in Imperial measure.

It has been stated in App. VII., p. 122, that the defining line of the metre at 32° F., marked on the bar 𝕾𝕾, is continued through the space between the defining lines of 39·38 and 39·39 inches, being 79 div. of the micrometer, or 0·00252642 in. distant from 39·38. Both the metre and the 40-inch scale on 𝕾𝕾 have the same defining line at 0.

Appendix XII.—*continued.*

The standard length of the Imperial measure defined by the line 39·38 has been determined as follows:—

See XIX.

Inches.
At 62° F. The yard of 0...36 in.=35·99990950
36...39 in. = 2·99981149
39·1...39·3 in. = 0·30017046
39·30...39·38 in.= 0·08000304

39·37989449
39·38 in. to metre line= 0·00252642

Length in Imperial inches at 62° F. of metre on 𝔖𝔖 at 62° F. =39·38242091
Deduct expansion of bronze bar for 30° F., at 0·00000947 = 0·01118800

Length in Imperial inches at 62° F. of the metre on 𝔖𝔖 at 32° F.=39·37123291
Deduct excess of 𝔖𝔖 in relation to the primary standard metre 0·00313 mm.= 0·00012324

∴ Length in Imperial measure of the primary metre des archives=39·37110967

If the rate of expansion of the bronze bar were taken according to Capt. Clarke's determination of 0·00000985, equivalent in a metre to 0·00985 mm. or 0·0003878 in. for 1° F., it would amount to 0·011634 in. for 30° F., or 0·000446 in. more than the rate of 0·00000947; and consequently the French metre would be equivalent at 32°=39·37071367 inches, which result approximates very nearly with Captain Kater's determination in 1818.

But it is obvious that before any such determination can absolutely be relied on, the actual rate of expansion of the standard bar or bars with which the observations are made, must be accurately determined.

Effect of difference of standard temperature on the stated equivalent.

One point, however, here arises with regard to the equivalent in Imperial measure of the metric unit of length which seems to deserve consideration.

It has been shown that for ordinary weighings in air, neither the primary kilogram in France, nor the primary Imperial pound in this country is practically taken as the standard, both being made of platinum, but a second commercial standard of brass or bronze is established as an intermediary in both countries, differing from the primary standard, the one 88 mgr., the other 0·645 grain in deficiency, being the difference of the weight of air displaced by the platinum and bronze standard weights respectively.

The primary standard of Imperial length in this country being a bronze yard, having its legal length at 62° F., or nearly the ordinary temperature of the atmosphere, requires no other commercial standard as an intermediary. But in France, where a brass metre at ordinary temperatures (62°) is longer by nearly 0·3 mm. (more than 0·01 inch) than its legal length at 32° F., and longer by nearly 0·15 mm. (more than 0·005 inch) than the platinum standard, there is no commercial standard of length, made of brass or bronze, where it would seem to be needed.

As no correction ever appears to be made in France for the expansion of commercial metres beyond the true length at 32° F., it follows that the commercial metre in ordinary use must always exceed the true length of a metre by the amount of expansion at ordinary temperatures.

In order to meet any difficulty which might arise in this country from this difference between the two standard temperatures, it has been resolved by the Commission, on the grounds stated in App. XV., that all departmental comparisons with the official standard metre be made at ordinary temperatures of the atmospheric air, or at 62° F., in the same manner as comparisons with the official Imperial standard measure of length.

Different *commerc* equivaler of the metre.

But there will still remain this result of the difference between the standard temperatures for measures of length in the two countries,—that although the legal Imperial equivalent of the primary standard metre at its true length may be justly stated to be 39·37079 inches, yet if a brass or bronze metre of accurate standard length be compared at ordinary temperatures with a similar measure of Imperial length, it will be found equivalent to more than 39·38 inches. In fact, it has been shown above that when marked upon the same bronze bar the metre has been found equal to 39·38342 inches. Taking the equivalent of the true metre at 32° F. = 39·37079 inches, and the mean expansion for 30° F. of a metre of bronze or brass (of which metals all local Standards for comparing and verifying metric measures for commercial use are made) = 0·01124 inch, it follows that the equivalent of the metre for all ordinary commercial transactions will be 39·38203 inches, or it may be taken sufficiently near at 39·382 inches. This, therefore, would more truly represent the *commercial* equivalent in Imperial measure of the French metre.

Verifica of decimetres 𝔖𝔖.

The verification of the ten decimetres marked on the bronze bar has been effected by ascertaining their relative length by comparison with the decimetre on the brass slider 𝔖, moving in the groove on its bronze bar, and then finding their absolute length in relation to the determined standard length of the metre.

The slight difference in the rate of expansion of bronze and brass has rendered it unnecessary to take any account of this difference in the comparison of a decimètre.

The following comparisons of the decimeters were taken between 3 p.m. and 4.45 p.m. on 16th November; the mean temperature of the bars marked by the thermometers placed upon them being 12·5° C. They were taken as rapidly as might be by Mr. Chisholm and Mr. Chaney, eight readings of the micrometers used, Nos. 3 and 4, being noted for each comparison. The results agree in every case within 0·00001 mm., with similar comparisons made during three successive days in June last, when 48 readings were taken for each comparison; and the result of experience tends to show that no greater accuracy is obtained by taking at one time numerous readings with the microscope of standard measures of length, where the greater heat of the body of the observer must necessarily affect the temperature, and consequent length of the bars, as well as parts of the comparing apparatus.

Comparisons of Decimetres marked on 𝔖𝔖.

Compared Decimetres.	Difference of compared Decimetres.	
	In Micrometer Divisions.	In parts of a Millimetre.
Decimetre 𝔖𝔖 0·0 .. 0·1=Decimetre 𝔖	+13·70	+0·01078
" 0·1 .. 0·2= "	+ 9·25	+0·00735
" 0·2 .. 0·3= "	+ 0·85	+0·00043
" 0·3 .. 0·4= "	0·00	−0·00030*
" 0·4 .. 0·5= "	+ 5·00	+0·00400
" 0·5 .. 0·6= "	+ 4·20	+0·00317
" 0·6 .. 0·7= "	+10·25	+0·00799
" 0·7 .. 0·8= "	+16·75	+0·01336
" 0·8 .. 0·9= "	+ 3·75	+0·00270
0·9 .. 1·0= "	0·00	−0·00084

* Viz. +99·5 div. of Micrometer No. 3= +0·08140284 mm.
−99·5 " No. 4= −0·08170591 "

−0·00030307 "

Fig. 1.

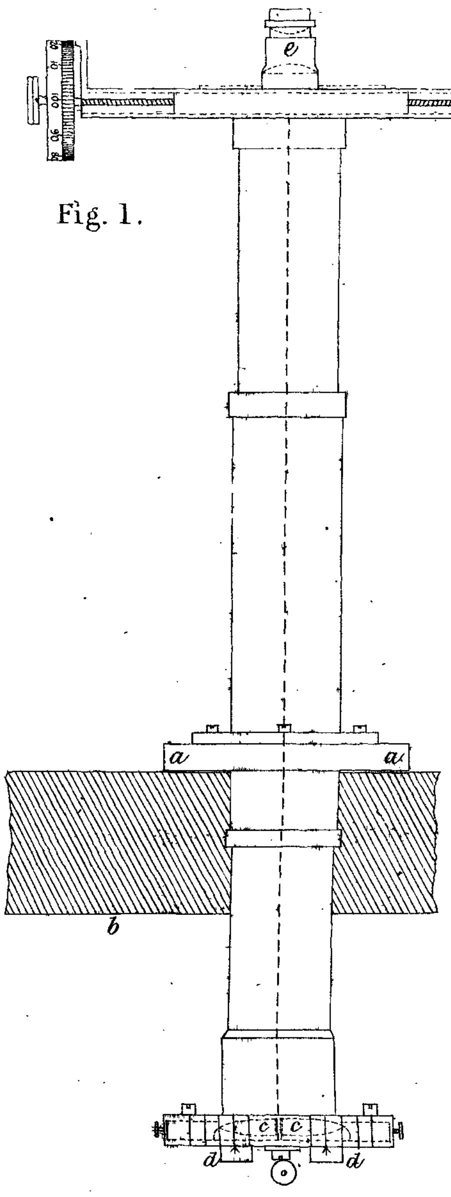

e
80
90
100
10
20
a
a
b
c
c
d
d

Fig. 2.

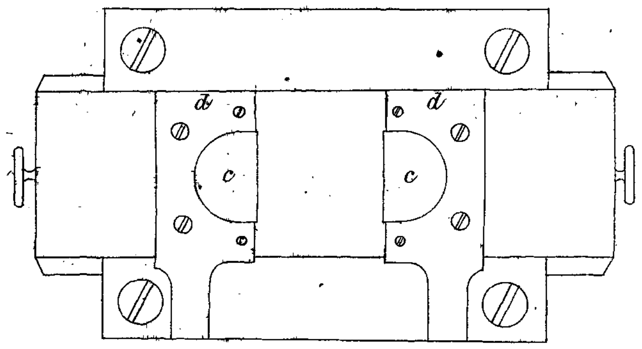


Fig. 3.

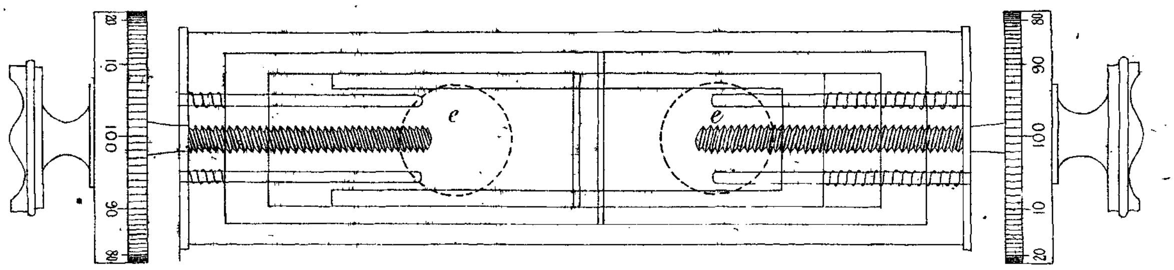
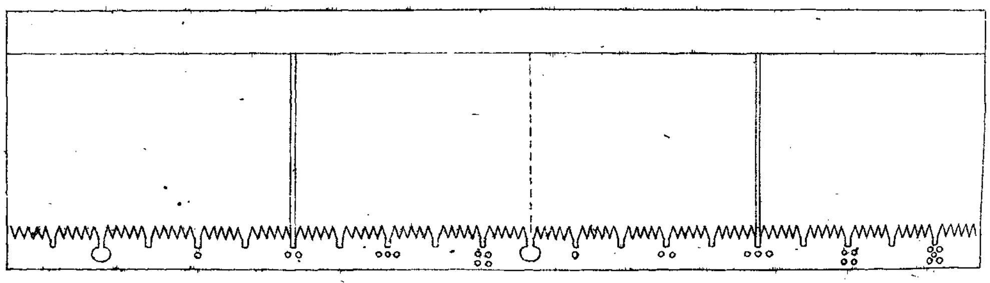

20
10
100
90
80
e
e
80
90
100
10
20

Fig. 4.



No 5 Microm^r.   No 6 Microm^r.

Vincent Brooks, Day & Son Lith.

Appendix XII.—*continued.*

Results of Comparisons.

Compared Decimetre.	Comparing Decimetre.	Difference of compared Decimetre.		Ascertained Error of compared Decimetre.	Standard Length of compared Decimetre at 0° C.
		In Micrometer Divisions.	In parts of a Millimetre.		
		div.	mm.	mm.	Metre.
0·0–0·1 𝔖𝔖	-	-	-	+0·00623	0·10000623
0·1–0·2 =	0·0–0·1 𝔖𝔖	– 4·45	–0·00343	+0·00280	0·10000280
0·2–0·3 =	„	–12·85	–0·01035	–0·00412	0·09999588
0·3–0·4 =	„	–13·70	–0·01108	–0·00485	0·09999515
0·4–0·5 =	„	– 8·70	–0·00678	–0·00055	0·09999945
0·5–0·6 =	„	– 9·50	–0·00761	–0·00138	0·09999862
0·6–0·7 =	„	– 3·45	–0·00279	+0·00344	0·10000344
0·7–0·8 =	„	+ 3·05	+0·00258	+0·00881	0·10000881
0·8–0·9 =	„	– 9·95	–0·00808	–0·00185	0·09999815
0·9–1·0 =	„	–13·70	–0·01163	–0·00540	0·09999460
Error of 10 (0·0 ... 0·1 𝔖𝔖) in relation to metre 𝔖𝔖			+0·05917		
Error of metre 𝔖𝔖 at 0° C. in relation to the Mètre des Archives (App. XII., p. 182).			+0·00313	+0·00313	1·00000313
Error of 10 (0·0 ... 0·1 𝔖𝔖) in relation to the Mètre des Archives (App. XII., p. 182).			+0·06230		
∴ Ascertained error of decimetre 𝔖𝔖 0·0 ... 0·1 at 0° C			+0·00623		

New micro-scope re-quired for centimetres.

Before any comparisons of the centimetres marked on 𝔖𝔖 could be made, an addition to the number of the microscopes was requisite, in order that the two defining lines of the centimetres could be properly viewed, as the field of each of the four microscopes did not extend beyond 0·05 inch, and two of the microscopes could not be brought together with their fields nearer to each other than one inch.

Description f new ouble icroscope.

A new double microscope has therefore been constructed for this special purpose by Messrs. Troughton and Simms, and was delivered by them at the Standards Office on November 14th, 1870. This double microscope has a moveable eye-piece, with a double lens, which slides in a groove upon a horizontal plate. There are two micrometer screws, the heads of which are graduated into 100 divisions, one on the right, the other on the left hand side; and these work the usual parallel cobweb lines along two measuring racks or combs as they are technically called. At the lower end of the microscope there are two object glasses, each of which is composed of a double lens, and slides upon a horizontal plate made exactly parallel to that upon which the eye-piece moves. When these object glasses are pulled out to the greatest extent, a measuring field of rather more than two centimetres in length is obtained.

The figures in Plate I. illustrate the construction of the new double microscope, and the combs of the two micrometers No. 5 and No. 6.

Fig. 1 shows a section of the double microscope, half size, with its heavy iron plate *a* attached and extending nearly across the stone shelf *b*, by the weight of which it is kept steady. The moveable eye-piece is shown at *e*. The body of the microscope is divided by a thin metallic plate in the line of its vertical axis and at right angles to the line in which the object glasses move. In front of the lower part of the microscope some graduated lines are traced, which serve to indicate the position of the two object glasses *c*, *c*, by means of arrow heads marked upon the two brass plates screwed to the sliding plates which carry these object glasses.

Fig. 2 shows the lower part of the double microscope, as seen from below, and of the full size.

Fig. 3 is a plan of the interior of the micrometer of the double microscope, also full size, and shows the mode in which the two frames carrying the parallel cobweb lines move one within the other by the action of the two screws with micrometer heads, and the pressure of spiral springs. The two double circles with dotted lines show the two extreme positions of the eye-piece over the micrometer chamber and the extent of its range.

No. 4 shows the measuring rack or combs for indicating the number of revolutions of the two micrometer heads, No. 5 and No. 6. It is drawn of the apparent size as seen through the eye-piece, and the traversing parallel cobweb lines. The dotted line is intended to show the thin dividing *plate of* the double microscope.

Magnifying power of the microscopes.

It will be seen that the microscopes used with the comparing apparatus for measures of length are compound, a magnified image formed in the plane of the wires by an achromatic lens (the object glass) being again enlarged by a system of two lenses known as the positive eye-piece. The total magnifying power is found by multiplying together the powers of the object glass and of the eye-piece. For this purpose the lens equivalent to the system of the eye-piece must be first found. The total magnifying power of each microscope is about 60 times.

Improved method of illumination.

The method of illumination by ordinary oil lamps in lanterns with common lenses hitherto adopted for the microscopes not proving satisfactory, after consultation with Mr. James Simms, and making some trials with gas and spirit lights and with larger and more powerful lenses, it has been determined to throw a beam of light along the backs of the microscopes just underneath the stone shelf by placing a gas or spirit light in the principal focus of a large lens at each end, and thus by attaching two refracting prisms to each microscope to obtain a more perfect illumination of the defining lines of measures of length.

Verification of micrometers Nos. 5 and 6 of new double microscope.

The value of the two micrometers, Nos. 5 and 6, of the new double microscope has been determined by the measurement of the ten hundredths of the inch 39 . . 40 of SS., by Mr. Chisholm and Mr. Chaney, on 21st November.

The following are the mean results of four separate comparisons of the number of divisions of the left-hand micrometer No. 5, for each one hundredth of an inch, in all fifteen hundredths, working *from right to left* from :: 4 to O 4 of the comb, or rather more than 48 division teeth. Two sets of readings were taken for each comparison, and the eye-piece was shifted after reading five hundredths of the inch. By this method only the central half of the breadth of the field was used for the observations.

Appendix XII.—*continued.*

Teeth of Comb.	Number of Divisions of Micrometer No. 5.	Comparing Hundredth of an Inch of SS.	Standard Length of comparing Hundredth of an Inch.	Consequent Value of 1 div. of Micrometer No. 5.
	div.		inch.	inch.
∷ 4 ... ∷ 1 - -	318=	39·30 ... 39·31	0·00985714	0·00003100
∷ 1 ... ∴ 8 - -	328=	39·31 ... 39·32	0·01017544	3102
∴ 8 ... ∴ 5 - -	323=	39·32 ... 39·33	0·00998446	3091
∴ 5 ... ∴ 1 - -	324=	39·33 ... 39·34	0·00995265	3072
∴ 1 ... •• 8 - -	321=	39·34 ... 39·35	0·00995265	3100
	1614=	39·30 ... 39·35	0·04992234	0·00003093
•• 8 ... •• 5 - -	323=	39·35 ... 39·36	0·01007995	0·00003121
•• 5 ... •• 2 - -	323=	39·36 ... 39·37	0·01007995	3121
•• 2 ... • 9 - -	324=	39·37 ... 39·38	0·00992080	3061
• 9 ... • 5 - -	321=	39·38 ... 39·39	0·01011178	3111
• 5 ... • 2 - -	320=	39·39 ... 39·40	0·00979347	3060
	1615=	39·35 ... 39·40	0·04998595	0·00003095
• 2 ... O 9 - -	324=	39·35 ... 39·36	0·01007995	0·00003111
O 9 ... O 5 - -	323=	39·36 ... 39·37	0·01007995	3121
O 5 ... O 2 - -	323=	39·37 ... 39·38	0·00992080	3072
O 2 ... 9 - -	323=	39·38 ... 39·39	0·01011178	3131
9 ... 5 - -	318=	39·39 ... 39·40	0·00979347	3080
	1611=	39·35 ... 39·40	0·04998595	0·00003103
Total -	4840=		0·14989424	0·00003097

∴ Mean value of 1 div. of micrometer No. 5 for the whole range of the screw = 0·00003097 inch. = 0·0007866 mm.

The results of similar readings of the right-hand micrometer No. 6, working *from left to right*, from tooth 6 to ∷ 4 of the comb, are as follows :—

Teeth of Comb.	Number of Divisions of Micrometer No. 6.	Comparing Hundredth of an Inch of SS.	Standard Length of comparing Hundredth.	Consequent Value of one div. of Micrometer No. 6.
			inch.	inch.
6 ... 9 - -	317 =	39·40 ... 39·39	0·00979347	0·00003090
9 ... • 2 - -	328 =	39·39 ... 39·38	0·01011178	3083
• 2 ... • 5 - -	325 =	39·38 ... 39·37	0·00992080	3053
• 5 ... • 9 - -	323 =	39·37 ... 39·36	0·01007995	3121
• 9 ... •• 2 - -	324 =	39·36 ... 39·35	0·01007995	3111
	1617 =	39·40 ... 39·35	0·04998595	0·00003092
•• 2 ... •• 5 - -	321 =	39·35 ... 39·34	0·00995265	0·00003101
•• 5 ... •• 8 - -	325 =	39·34 ... 39·33	0·00995265	3062
•• 8 ... ••• 2 - -	324 =	39·33 ... 39·32	0·00998446	3082
••• 2 ... ••• 5 - -	336 =	39·32 ... 39·31	0·01017544	3121
••• 5 ... ••• 8 - -	318 =	39·31 ... 39·30	0·00985714	3100
	1614 =	39·35 ... 39·30	0·04992234	0·00003093
••• 8 ... ∷ 1 - -	320 =	39·35 ... 39·34	0·00995265	0·00003110
∷ 1 ... ∷ 5 - -	323 =	39·34 ... 39·33	0·00995265	3082
∷ 5 ... ∷ 8 - -	321 =	39·33 ... 39·32	0·00998446	3110
⁙ 8 ... ⁙ 1 - -	324 =	39·32 ... 39·31	0·01017544	3141
⁙ 1 ... ⁙ 4 - -	320 =	39·31 ... 39·30	0·00985714	3080
	1608 =	39·35 ... 39·30	0·04992234	0·00003105
Total -	4839 =		0·14983063	0·00003097

∴ Mean value of 1 div. of micrometer No. 6 for the whole range of the screw = 0·00003097 inch. = 0·0007866 mm.

Appendix XII.—*continued.*

Decimal table of values of the divisions of micrometers Nos. 5 and 6.

The following decimal table shows accordingly both the Imperial and the Metric values of from 1 to 10 divisions of each of these two micrometers Nos. 5 and 6 of the new double microscope:—

DECIMAL TABLE OF VALUES OF THE DIVISIONS OF MICROMETERS NOS. 5 AND 6, FOR THE WHOLE RANGE OF THE SCREW.

No. of Divisions.	Micrometers, Nos. 5 & 6.		No. of Divisions.	Micrometers, Nos. 5 & 6.	
	In Imperial Measure.	In Metric Measure.		In Imperial Measure.	In Metric Measure.
	inch.	mm.		inch.	mm.
1	0·00003097	0·0007866	6	0·00018582	0·0047196
2	6194	0·0015732	7	21679	55062
3	9291	23598	8	24776	62928
4	0·00012388	31464	9	27873	70734
5	15485	39330	10	30970	78660

Verification of centimetres of 𝔖𝔖.

The following comparisons of the ten centimetres of the subdivided decimetre 0·9 .. 1·0 marked on 𝔖𝔖 were made on 19th November, with the new double microscope, using the whole range of the field:—

Compared Centimetres of 𝔖𝔖.	Comparing Centimetre.	Difference of compared Centimetre.	
		In Micrometer Divisions.	In parts of a Millimetre.
		div.	mm.
0·90 ... 0·91 =	0—1 of 𝔖 -	−11·5	−0·00905
0·91 ... 0·92 =	„ -	−16·5	−0·01298
0·92 ... 0·93 =	„ -	−14·0	−0·01101
0·93 ... 0·94 =	„ -	−15·5	−0·01219
0·94 ... 0·95 =	„ -	−12·0	−0·00944
0·95 ... 0·96 =	„ -	−13·0	−0·01022
0·96 ... 0·97 =	„ -	−10·5	−0·00826
0·97 ... 0·98 =	„ -	− 6·5	−0·00511
0·98 ... 0·99 =	„ -	−10·0	−0·00787
0·99 ... 1·00 =	„ -	− 8·0	−0·00629
And decimetre 0·9 ... 1·0 =	10 (0—1 of 𝔖)	117·5	−0·09242

Compared Centimetre.	Comparing Centimetre.	Difference of compared Centimetre.		Ascertained Error of compared Centimetre.	Standard Length of compared Centimetre.
		In Div.	In mm.		
		div.	mm.	mm.	Centimetre.
0·90 ... 0·91	—	—	—	−0·00073	0·999927
0·91 ... 0·92	0·90 ... 0·91	+5·0	+0·00393	+0·00319	1·000319
0·92 ... 0·93	„	+2·5	+0·00197	+0·00123	1·000123
0·93 ... 0·94	„	+4·0	+0·00315	+0·00241	1·000241
0·94 ... 0·95	„	+0·5	+0·00039	−0·00034	0·999966
0·95 ... 0·96	„	+1·5	+0·00118	+0·00044	1·000044
0·96 ... 0·97	„	−1·0	−0·00079	−0·00153	0·999847
0·97 ... 0·98	„	−5·0	−0·00393	−0·00466	0·999534
0·98 ... 0·99	„	−1·5	−0·00118	−0·00192	0·999808
0·99 ... 1·00	„	−3·5	−0·00276	−0·00349	0·999651
Whence 10 (0·90 ... 0·91) = Decimetre 0·90—2·5 -			−0·00196		
Ascertained error of Decimetre „ =			−0·00540	−0·00540	9·999460=Decimetre 0·9—1·10
Ascertained error of 10 (Centimetre 0·90 ... 0·91) -			−0·00736		

∴ Ascertained error of Centimetre 0·90 ... 0·91 of 𝔖𝔖 - −0·00073

Centimetre.
And as 10 (0...1 of 𝔖) = Decimetre 0·90...1·00 + 0·009242
or = 10·008702

∴ Centimetre 0...1 of 𝔖 = 1·000870

Beyond the metre marked on 𝔖𝔖, there is an additional centimetre, 1·00 ... 1·01, divided into millimetres; its length has been verified on 21st November, as follows:—

Centimetre 1·00...1·01 of 𝔖𝔖=centimetre 0—1 of 𝔖+2·5 div., or+0·00196 mm.
∴ „ 1·00...1·01 of 𝔖𝔖=1·001066 cm.

Appendix XII.—*continued.*

Verification of millimetres of 𝕾𝕾.

COMPARISON of MILLIMETRES of SUBDIVIDED CENTIMETRE 1·00 ... 1·01 of 𝕾𝕾 with No. 2 Micrometer, on 21st November 1870.

Millimetres.		Divisions of Micrometer No. 2.	Millimetre.		Divisions of Micrometer No. 2.
1·000 ... 1·001	=	1233·0	1·005 ... 1·006	=	1233·3
1·001 ... 1·002	=	1234·6	1·006 ... 1·007	=	1230·3
1·002 ... 1·003	=	1233·3	1·007 ... 1·008	=	1230·3
1·003 ... 1·004	=	1232·0	1·008 ... 1·009	=	1230·6
1·004 ... 1·005	=	1230·6	1·009 ... 1·010	=	1234·6

RESULTS OF COMPARISONS.

Compared Millimetre.	Comparing Millimetre.	Difference of Compared Millimetre.		Ascertained Error of compared Millimetre.	Standard Length of compared Millimetre.
		In Division.	In parts of a Millimetre.		
		div.	mm.	mm.	mm.
1·000 ... 1·001 =	—	—	—	+0·00166	1·00166
1·001 ... 1·002 =	1·000 ... 1·001 - -	+1·6	+0·00129	+0·00295	1·00295
1·002 ... 1·003 =	„ - -	+0·3	+0·00024	+0·00190	1·00190
1·003 ... 1·004 =	„ - -	−1·0	−0·00081	+0·00086	1·00086
1·004 ... 1·005 =	„ - -	−2·4	−0·00194	−0·00027	0·99973
1·005 ... 1·006 =	„ - -	+0·3	+0·00024	+0·00190	1·00190
1·006 ... 1·007 =	„ - -	−2·7	−0·00218	−0·00051	0·99949
1·007 ... 1·008 =	„ - -	−2·7	−0·00218	−0·00051	0·99949
1·008 ... 1·009 =	„ - -	−2·4	−0·00194	−0·00027	0·99973
1·009 ... 1·010 =	„ - -	+1·6	+0·00129	+0·00295	1·00295
Here 10 (1·000 ... 1·001) = centimetre 1·00 ... 1·01 of 𝕾𝕾		−7·7	+0·00599		
Ascertained error, &c. of „ „ -			+0·01066	+0·01066	10·01066
Whence error of 10 (1·000 ... 1·001) - - -		=	+0·01665		
And error of 1·000 ... 1·001 - - - -		=	+0·00166		

PART 3.—VERIFICATION OF OFFICIAL METRIC MEASURES OF CAPACITY.

CONTENTS.

Page

Description of Metric standard measures of capacity - 190

Mode of comparison - - - - - 191

Corrections for temperature and atmospheric pressure - „

Formula for computing corrections - - - „

  For a brass litre - - - - - „

  For ascertaining the weight of a litre of air - - „

Tables of logarithms for computing corrections - - „

Example of computing the correction for a brass litre - „

Actual comparisons of official Metric standard measures of capacity - - - - - - - 192

Reductions of these comparisons - - - - „

Tables of corrections for temperature and atmospheric pressure - - - - - - - 193

  Tables used in France - - - „

  „ „ Germany - - - - „

  Dr. Förster's "Metronomische Beiträge" - - „

  Data for computing the German table - - „

  Comparative table of rates of expansion of water - „

  Comparative table of corrections for a brass litre - „

Desirability of adopting uniform tables of corrections - 194

Rate of expansion of brass adopted in the Standards Department - - - - - - „

Direct comparison of Standard litres 𝕮 and 𝕷𝕭 by measurement of water - - - - - „

Page

Verification of glass burette Metric measures of capacity:

  Standard glass burettes for *delivering* the specified measure - - - - - - - 194

  First comparison of glass burette litre with 𝕷𝕭 by measurement of water - - - - 195

  Method of comparison - - - - „

  Correction for expansion - - - - „

  Formula for this correction - - - - „

  Cubic expansion of glass - - - - „

  Results of this comparison of the glass burette litre - „

  Experiment of reducing the water in the glass burette from 62° to 32° F. - - - - - „

  Mode of verification by weighing their contents of water - - - - - - 196

  Verification of glass burette measures by weighing their contents of water - - - - „

  Table of correction for glass metric measures - „

  Weighings of standard metric glass burettes - 197

  Results of these weighings - - - - „

  Verification of litre glass flask - - - „

  Comparisons of the several litre measures with each other - - - - - - 198

Construction of complete series of standard glass flask of Metric and of Imperial measure - - - „

VERIFICATION OF OFFICIAL METRIC STANDARD MEASURES OF CAPACITY.

Description of Metric standard measures of capacity.

The brass Metric measures of capacity, which form part of the set of Metric standards made by Deleuil, Paris, and purchased for the Standards Department from Messrs. Tylor (distinguished as series 𝕮), comprise the following measures:—each marked with its specified legal denomination and "Deleuil à Paris," and purporting to contain the specified metric weight of distilled water at its maximum density, usually taken at 4° C., viz.:—

Double décalitre,	being	20	litres	or	20 kilog.	weight of water.
Décalitre	„	10	„		20 „	„
Double litre	„	2	„		20 „	„
Litre	„	1	„		1 „	„
Demi-litre	„	0·5	„		500 gram.	„
Double décilitre	„	0·2	„		200 „	„
Décilitre	„	0·1	„		100 „	„
Demi-décilitre	„	0·05	„		50 „	„
Double centilitre	„	0·02	„		20 „	„
Centilitre	„	0·01	„		10 „	„

In cubic measurement one cubic decimetre is equal to a

Appendix XII.—*continued.*

kilogram weight of distilled water, and one cubic centimetre to a gramme weight.

Mode of comparison.

These metric measures have been verified by a similar method to that adopted in the verification of the official standards measures of capacity of the Imperial system, by weighing their contents of distilled water against the standard weights of the same series 𝕮, both being counterpoised by brass weights, and by afterwards making the necessary corrections for the temperature of the water and for atmospheric pressure.

Corrections for temperature and atmospheric pressure.

The corrections have been computed upon the same principles as those upon which the tables of corrections for the Imperial standard measures of capacity were based, reducing the temperature of the water to 4° C., or 39·2° Fahr. instead of 62° F., and the comparing brass weights to their weight in a vacuum, instead of their weight in air $t = 62°$ F., $b = 30$ inches.

Formula for computing corrections.

The formula for ascertaining the amount of correction for temperature and atmospheric pressure after weighing the contents of water in Metric measures of capacity has been thus given by Professor Miller for use in the Standards Department.

For a Brass Litre.

For a brass litre.

The coefficient of linear expansion of cast brass for 1° C. having been determined by Mr. Sheepshanks at ordinary temperatures of the atmospheric air, to be 0·00001722, and its cubic expansion being $3 \times 0{\cdot}00001722 = 0{\cdot}00005166$;

At t, volume of a brass litre = litre $(1+0{\cdot}00005166 \times t)$; Let W_t = the ratio of the maximum density of water to its density at $t°$.

Then in vacuo, the weight of water in a brass litre at $t° = \frac{1+0{\cdot}00005166\times t}{W_t}$ 1000 grammes.

In air, let the brass litre filled with water at $t° = (1000-x)$ grammes;

Then $\frac{1+0{\cdot}00005166\times t}{W_t}$ 1000 grammes—weight of litre of air = $(1000-x)$ grammes of brass—weight of air displaced by $(1000-x)$ grammes of brass.

Suppose density of brass = 8 times density of water, then x being comparatively small;

Volume of 1000 grammes of brass = $\frac{1}{8}$ litre.

Hence,

$$\frac{1+0{\cdot}00005166\times t}{W_t}\ 1000 \text{ grammes}-(1000+x) \text{ grammes}$$

= $\frac{7}{8}$ weight of litre of air.

Tables of logarithms of W_t for every fifth of a centesimal degree of temperature, computed by Professor Miller, are given in Table VI. of Appendix V. (p. 68).

For ascertaining the weight of a litre of air.

The following formula for ascertaining the weight of a litre of air is given by Professor Miller in his account of the construction of the Imperial Standard pound:—

Miller, p 785.

$$\text{Litre of air} = \frac{1{\cdot}293893}{1+0{\cdot}003656t} \times \frac{b-0{\cdot}378v}{760} \text{ grammes.}$$

Here 1·293893=the ascertained weight in grammes, according to Regnault's observations of a litre of dry air containing an average amount of 0·0004 of its volume of carbonic acid, weighed at the temperature of 0° C. and under pressure of 760 mm. of mercury at 0° C., at Cambridge in lat. 52° 12′ 18″ about 8 mètres above the mean level of the sea.

And 0·003656=the coefficient of expansion of dry air for 1° C. according to Regnault's observations from 0° to 50°, corrected for the difference between the mercurial and air thermometers.

b = barometric pressure in millimètres of mercury at 0° C.

v = pressure of vapour present in the air, also expressed in millimètres of mercury at 0° C.

The values of $0{\cdot}378\,v$, at two-thirds of the maximum pressure, which is taken to be the average pressure of vapour in rooms that are not heated artificially, have been computed in millimètres of mercury at 0° C. by Professor Miller, and is shown in Table II. of Appendix V. (p. 35).

Tables of logarithms for computing corrections.

The following tables of logarithms have been used in computing the corrections according to Professor Miller's formula:—

TABLE VII.

LOGARITHMS of the RATIOS of the DENSITY of BRASS at 0° C. to its Density at $t°$, assuming the Coefficient of Cubic Expansion of Brass = 0·00005166.

t.	log.	*t.*	log.	1=224
0° C.	=0·0000000	12° C.	=0·0002691	0·1= 22·4
1	=0·0000224	13	=0·0002915	0·2= 44·8
2	=0·0000449	14	=0·0003139	0·3= 77·2
3	=0·0000673	15	=0·0003364	0·4= 99·6
4	=0·0000898	16	=0·0003588	0·5=112·0
5	=0·0001122	17	=0·0003812	0·6=134·4
6	=0·0001346	18	=0·0004036	0·7=156·8
7	=0·0001570	19	=0·0004261	0·8=179·2
8	=0·0001794	20	=0·0004485	0·9=201·6
9	=0·0002018	21	=0·0004709	
10	=0·0002243	22	=0·0004933	
11	=0·0002467	23	=0·0005157	

TABLE VIII.

LOGARITHMS of the RATIOS of the DENSITY of GLASS at 0° C. to its Density at $t°$, assuming the Coefficient of Cubic Expansion of Glass = 0·00002658.

t.	log.	*t.*	log.	1=115
8° C.	=0·0000924	16° C.	=0·0001846	0·1= 11·5
9	=0·0001039	17	=0·0001962	0·2= 23·0
10	=0·0001155	18	=0·0002078	0·3= 34·5
11	=0·0001270	19	=0·0002193	0·4= 46·0
12	=0·0001385	20	=0·0002308	0·5= 57·5
13	=0·0001501	21	=0·0002424	0·6= 69·0
14	=0·0001616	22	=0·0002539	0·7= 80·5
15	=0·0001731	23	=0·0002654	0·8= 92·0
				0·9=103·5

TABLE IX.

TABLE of LOGARITHMS of $\frac{760-0{\cdot}378\,v}{760}$ from 8° to 23° C.

t.	log.	*t.*	log.
8° C.	−0·0015559	16° C.	−0·0019530
9	−0·0012361	17	−0·0020793
10	−0·0013220	18	−0·0022171
11	−0·0014138	19	−0·0023607
12	−0·0015112	20	−0·0025102
13	−0·0016087	21	−0·0026711
14	−0·0017177	22	−0·0028379
15	−0·0018325	23	−0·0030162

TABLE X.

LOGARITHMS of the RATIOS of the DENSITY of AIR under constant Pressure at 0° to its Density at $t°$, assuming the Coefficient of Expansion of Air = 0·003656.

t.	log.	*t.*	log.
8° C.	=0·0125200	16° C.	=0·0246892
9	=0·0140600	17	=0·0261866
10	=0·0155944	18	=0·0276790
11	=0·0171235	19	=0·0291662
12	=0·0186472	20	=0·0306483
13	=0·0201656	21	=0·0321253
14	=0·0216787	22	=0·0336046
15	=0·0231866	23	=0·0350645

Example of computing correction of a brass litre.

The following is an example of the method of ascertaining the correction for temperature and atmospheric pressure in weighing the contents of water in Metric measures of capacity:—

Appendix XII.—*continued.*

To find the correction of a litre of water contained in a brass standard measure weighed by brass weights $t{=}16°$, $b{=}760$ mm.

$$\begin{aligned}
\text{Log. } (1 + 0{\cdot}00005166\,t) &= 0{\cdot}0003588 \\
\text{Log. } 1{,}000 \text{ grammes} &= 3{\cdot}0000000 \\
&\overline{3{\cdot}0003588} \\
\text{Deduct log. W}t &= 0{\cdot}0004378 \text{ grammes.} \\
&\overline{2{\cdot}9999210} \quad = 999{\cdot}818
\end{aligned}$$

To find the weight of a litre of dry air, $t{=}16°$, $b{=}760$ mm.

$$\begin{aligned}
\text{Log. } 1{\cdot}293893 &= 0{\cdot}1118983 \\
\text{Log. } \frac{b - 0{\cdot}378\,v}{760} &= 0{\cdot}0019530 \\
&\overline{0{\cdot}1099453} \\
\text{Deduct log. } (1 + 0{\cdot}003656\,t) &= 0{\cdot}0247114 \\
&\overline{0{\cdot}0852339} \\
\text{or } 1{\cdot}217 \text{ gr.} \times \tfrac{7}{8} &= -1{\cdot}065 \text{ gr.} \\
&\overline{998{\cdot}753}
\end{aligned}$$

Hence $1000 - 998{\cdot}753 = 1{\cdot}247$ grammes, shows the requisite correction to be added to the weight of the water contained in the brass litre weighed in air, $t = 16°$ C., $b = 760$ mm.

If the coefficient of cubic expansion of brass were taken to be 3 × 0·00001875, as usually adopted in France, the correction would in like manner amount to 1·164 grammes.

Actual comparison of official metric standard measures of capacity.

ACTUAL COMPARISON of OFFICIAL METRIC STANDARDS of CAPACITY.

No. of Com.	Date of Comparison.	Weight of Water contained in compared Standard.	Comparing Standard Weights.	Difference in Divisions.	Value of one Division in Grammes.	Description of Balance.	Difference in Grammes.
	1870.						
(1)	April 27	Double decalitre : +10, 5, 2 grm. 𝕿 (or 17·000 grm.)	≏20 k 𝕿 (or 20000·3905 grm.)	div. + 2·55	gram. 0·0537	Kater's	gram. +0·137
(2)	„ 28	Double decalitre : +10, 5, 1 grm. 𝕿 (or 16·001 grm.)	≏20 k 𝕿 (or 20000·3905 grm.)	+ 7·00	0·0519	„	+0·363
(3)	„ 27	Decalitre : +5, 2 grm. 𝕿 (or 7·001 grm.)	≏10 k 𝕿 (or 1000·00025 grm.)	− 6·87	0·0579	„	−0·109
(4)	„ 21	Demi-decalitre : +50, 3 grains (or 3·424 grm.)	≏5 k 𝕿 (or 5000·370 grm.)	−29·00	0·0511	„	+1·484
(5)	„ 26	Double litre : +1 grm. 𝕿 + 1 dgr. 𝕭 (or 1·100 grm.)	≏2 k 𝕿 (or 2000·200 grm.)	+12·77	0·0506	No. 1 -	+0·647
(6)	„ „	Litre : +5, 2, 1, 1′ dgr. 𝕭 (or 0·899 grm.)	≏1 k 𝕿 (or 999·962 grm.)	− 1·97	0·004	No. 2 -	−0·008
(7)	„ „	Demi-litre : +2, 1 dgr. 𝕭 (or 0·300 grm.)	≏500 grm. 𝕿 (or 499·999 grm.)	− 9·45	0·008	„	−0·083
(8)	„ „	Double decilitre : +1 dgr., 2 cgr. 𝕭 (or 0·120 grm.)	≏200 grm. 𝕿 (or 200·007 grm.)	+18·60	0·007	„	+0·015
(9)	„ 27	Decilitre : +5 cgr., 2 mgr. 𝕭 (or 52·22 mgr.)	≏100 grm. 𝕿 (or 100·002 grm.)	+12·97	0·002	No. 3 -	+0·026
(10)	„ „	Demi-decilitre : +2 cgr., 1′ cgr., 5 mgr. 𝕭 (or 35·32 mgr.)	≏50 grm. 𝕿 (or 50·002 grm.)	−20·35	0·009	„	−0·019
(11)	„ 28	Double centilitre - - -	≏20 grm. 𝕿 (or 20·001 grm.)	+ 4·12	0·002	No. 4 -	+0·008
(12)	„ „	Centilitre: +2 mgr. 𝕭 (or 2·18 mgr.)	≏10 grm. 𝕿 (or 10·000 grm.)	−10·67	0·001	„	−0·001

These weighings have been corrected according to Professor Miller's formula, as follows :—

REDUCTIONS of COMPARISONS of OFFICIAL METRIC STANDARD MEASURES.

No. of Comparison.	Standard Compared.	Temperature.	Barometer at 0° C.	Weight of Water contained in Standard compared at stated t and b.	Correction for Temperature and Pressure.	Actual Weight of Water contained in Standard compared.	Ascertained Error of compared Standard in Grammes Weight of Water.
		° C.	mm.	grammes.	grammes.	grammes.	grammes.
(1)	Double decalitre - -	14·4	765·64	19983·526	+22·312	20005·838	+5·838
(2)	Do. - - -	13·95	764·93	19984·753	+21·587	20006·340	
					Mean	20006·089	+6·089
(3)	Decalitre - - -	14·62	765·80	9992·891	+11·346	10004·237	+4·237
(4)	Demi-decalitre -	15·67	767·82	4995·453	+ 6·162	5001·615	+1·615
(5)	Double litre - -	14·94	765·84	1999·747	+ 2·326	2002·073	+2·073
(6)	Litre - - -	15·42	765·69	999·055	+ 1·208	1000·263	+0·263
(7)	Demi-litre - - -	15·55	765·28	499·616	+ 0·612	500·228	+0·228
(8)	Double decilitre - -	15·65	765·28	199·901	+ 0·246	200·147	+0·147
(9)	Decilitre - - -	14·66	765·66	99·976	+ 0·114	100·090	+0·090
(10)	Demi-decilitre - -	15·27	765·84	49·947	+ 0·061	50·008	+0·008
(11)	Double centilitre - -	14·97	764·39	20·009	+ 0·023	20·032	+0·032
(12)	Centilitre - - -	15·44	764·15	10·001	+ 0·012	10·013	+0·013

Appendix XII.—*continued.*

les of rrection tempe- ture and mospheric ressure.

For the purpose of more readily ascertaining the requisite corrections for temperature and atmospheric pressure in weighing the contents of Metric measures of capacity, it has been found desirable to adopt tables similar to those used for Imperial measures.

les used rance.

The table of corrections for metric measures of capacity used in France, which was drawn up under the direction of the French Government by M. Coriolis, member of the Institute, has been mentioned in the Paper on the law and practice of the metric system in France appended to the Second Report of the Standards Commission. It shows the corrections for temperature between 0° and 30° C., the barometric pressure being assumed to be constant at the normal height of 760 mm. at 0° C., the hygrometrical condition of the air corresponding with 0·5 saturation of moisture, and the cubic expansion of the brass weights and measures being taken as 3×0·00002108 for 1° C. Halstrom's determination of the rate of expansion of water was taken.

The French table of M. Coriolis has since been superseded by a table drawn up by M. Tresca for the reverification of the local standard measures of capacity lately effected at the Conservatoire des Arts et Métiers, as mentioned in App. XI., p. 164. This table is based on the cubic expansion of brass being 3 × 0·00001875, and the expansion of air and of water as determined by M. Regnault.

es used ermany.

The most recently constructed tables of correction for Metric measures of capacity are those computed for the Standards Commission of the North German Confederation. These are contained in their official instructions, a translation of which is appended to the Fourth Report of the British Standards Commission. These tables show the corrections for all temperatures between 8° and 23° C., and for barometric pressures between 710 mm. and 810 mm. An additional table shows also the weight of a litre of air, corresponding with every reading of the thermometer and barometer between 8° and 24° C. and 710 mm. to 810 mm.

Rep., XI., 3.

Förster's etro- ische räge."

The data upon which these German tables are based are not stated in the Paper which contains them. But a later Paper by Dr. Förster, published at Berlin, and dated July 1870, entitled "Metronomische Beiträge, No. 1," besides containing much valuable information upon the subject of the volume and weight of water and of air, and their density as affected by temperature, &c. with reference to the weighings of standards, together with several further tables for aiding computations, gives also the data upon which these and the former tables were based.

a for puting German es.

Adopting the formula stated by Professor Miller for ascertaining the weight of a litre of dry air according to Regnault's observations, with the requisite corrections for latitude and height above the level of the sea, Dr. Förster computes the weight of a litre of dry air at Berlin, lat. 52° 30′, and 40 mètres above the mean level of the sea, =1·29388 grammes.

Dr. Förster states that the following coefficients of linear expansion for 1° C. were adopted in computing the tables of deviations for Metric measures of capacity in the North German Confederation :—

Copper	=0·00001717	Tin	=0·00002483
Brass	=0·00001886	Iron	=0·00001126

The expansion of glass being nearly the same as that of iron is taken to be identical with it. The coefficient of expansion of air is taken at 0·003665, according to Regnault's determination from 0° to 100° C. For reductions of barometer readings, he takes the coefficient of cubic expansion of quicksilver=0·00018153.

With regard to the expansion of water Dr. Förster refers to the several observations upon the mean of which Professor Miller's formula was based, as well as to those more recently made by Hagen, Jolly, Matthiessen, and Rosetti, and he gives the mean of all the observations. This differs so very little from Professor Miller's formula of the expansion of a litre of water from 4° to 18°, that he would propose no alteration. But between 18° and 24° there appears to be a progressive diminution from Professor Miller's formula though to the extent of 7 only.

Comparative table of rates of expansion of water.

The following table shows a comparison between the rates of expansion of water at various temperatures as given by Professor Miller, and the later corrections by Dr. Förster, the maximum density of water being taken at 3·945° C. by the former, and at 4° C. in round numbers by Dr. Förster.

COMPARATIVE TABLE of the RATIOS of the MAXIMUM DENSITY of WATER to its Density at t.

Temperature, Centigrade.	Prof. Miller.	Dr. Förster.
3·945° or 4°	1·000000	1·0000000
5	8	83
6	31	312
7	69	688
8	121	1205
9	186	1860
10	265	2650
11	357	3575
12	463	4630
13	581	5806
14	712	7110
15	854	8533
16	1009	10075
17	1175	11731
18	1352	13499
19	1540	15375
20	1739	17355
21	1948	19438
22	2167	21623
23	2396	23901
24	2634	26274
25	2882	—

Comparative table o corrections for a brass litre.

A comparative table of the several corrections for a litre of distilled water contained in a brass standard measure, when weighed against brass weights in air of the stated temperatures, the barometer being at 760 mm. as respectively computed for Paris by M. Coriolis, and later by M. Tresca; for Berlin by Dr. Förster; and according to Professor Miller's formula for the Standards Department at London;—is shown by the following abstract :—

ABSTRACT of TABLES of CORRECTION for the Weight to be added to a Litre of Water in a Brass Standard Measure when weighed against Brass Weights.

b =760 mm.	French Tables.		Prussian Tables.	Professor Miller's Formula.
	M. Coriolis.	M. Tresca.	Dr. Förster.	
	gram.	gram.	gram.	gram.
t = 8° C.	0·693	0·776	0·760	0·805
9	0·680	0·791	0·764	0·818
10	0·680	0·802	0·783	0·840
11	0·692	0·840	0·815	0·870
12	0·715	0·890	0·860	0·925
13	0·751	0·952	0·917	0·987
14	0·800	1·026	0·987	1·058
15	0·861	1·112	1·069	1·147
16	0·933	1·210	1·163	1·247
17	1·016	1·320	1·268	1·357
18	1·111	1·442	1·386	1·479
19	1·218	1·576	1·512	1·618
20	1·336	1·722	1·651	1·753
21	1·465	1·880	1·800	1·906
22	1·606	2·050	1·957	2·069
23	1·757	2·232	2·126	2·242

Appendix XII.—*continued.*

—	French Tables.		Prussian Tables.	Professor Miller's Formula.
	M. Coriolis.	M. Tresca.	Dr. Förster.	
Based on the following data :—	gram.	gram.	gram.	gram.
Coefficient of cubic expansion for 1° C. of brass -	0·00006324	0·00005625	0·00005666	0·00005166
„ „ „ quicksilver	0·00018018	0·00018153	0·00018153	0·00017971
„ „ „ dry air -	0·003666	0·0003665	0·0003665	0·003656
Weight of litre of dry air, $t=0°$ C., $b=760$ mm. -	1·2291	1·2932227	1·29388	1·293893

For barometric pressures differing from 760 mm., it would appear from the Prussian Table III. that the corrections for a litre increases or diminishes 1·4 mgr. for every 1 mm. of pressure above or below 760 mm. With reference to this table it may be noticed that in the verification at Paris of the standard brass litre (*see* App. XI., p. 164) at t of water$=16°$ C., and $b=755·19$ mm. at 0° C., it was found that an additional weight of 1·210 grm. to the litre of water was insufficient to establish an approximate equipoise with a brass kilogram, and 1·257 grm. was required.

Desirability of adopting uniform tables of corrections.

It is much to be desired that a common table of corrections for weighing the contents of water of Metric measures of capacity should be agreed upon in all countries where the Metric system is adopted, to be based as far as possible on a uniform data to be determined by scientific men, as regards the density and expansion of water, air, and the several materials of which the weights and measures, or other instruments are composed. A fit opportunity for such agreement may be afforded by the meeting at Paris of the members of the International Commission of Metric Standards.

Rate of expansion of brass adopted in the Standards Department.

As the rate of expansion of brass at ordinary temperatures adopted in the Standards Department, has been taken at considerably less than the rate from 0° to 100°, which is generally accepted in France and in Germany, it may be desirable to refer more particularly to the observations and data upon which this lesser rate has been based.

Mr. Sheepshanks's first determinations for the Standard Committee of 1843, of the thermometric expansions of metals at ordinary temperatures were based on the observations made by Mr. Simms in 1844, under the general instructions of Mr. Baily, with some suggestions by Mr. Airy; the details of these observations are shown in Mr. Airy's Account. Mr. Sheepshanks, after discussing these experiments, fixed upon the following rates as representing the mean linear expansion for 1° Fahr. at ordinary temperatures differing little from 62° Fahr.

See Airy's Account, Phil. Trans., 1857, p. 18.

Coefficient of Linear Expansion.	For 1° Fahr.	For 1° C.
Brass - - -	0·000009826	0·00001768
Bronze (Baily's metal)	0·000009416	0·00001695
Copper - -	0·000009055	0·00001720
Steel - - -	0·000005888	0·00001060
White glass - -	0·000004944	0·00000890

But the thermometers used for these experiments not having been deemed altogether trustworthy, a second series of experiments at ordinary temperature (between 36° and 78° F. or 2·22° and 25·56° C.), was made by Mr. Sheepshanks, with newly constructed thermometers which were made and verified with the greatest care, and have since served as the Standard thermometers in this country. They are now at the Royal Observatory, Greenwich, in the custody of the Astronomer Royal. The results of these later determinations were as follows :—

Ibid., p. 48.

Coefficients of Linear Expansion.	*For 1° Fahr.*	*For 1° C.*
Brass - - -	*0·000009566*	*0·00001722*
Bronze (Baily's metal)	*0·000009453*	*0·00001701*
Iron - - -	*0·000006166*	*0·00001110*

These determinations were adopted by the Standards Committee.

Direct comparison of standard litres 𝕿 an 𝕷𝕭, by measurement of water.

The before stated result of the verification of the litre 𝕿 has been tested by a direct comparison with the brass standard litre 𝕷𝕭 which was verified at Paris; the capacity of each Standard litre, when corrected for temperature and atmospheric pressure by M. Tresca's table, having been found as follow :—

Standard litre 𝕷𝕭 = 999·974 grammes weight of water.
„ 𝕿 = 1000·243 „ „

Whence 𝕿=𝕷𝕭 + 0·217 „ „

By the most careful measurement of water no sensible difference could be found between the two Standard litres.

By weighing 𝕿 filled with water against 𝕷𝕭 filled with water, after having previously equipoised the two brass measures with their glass discs, the following results were obtained :—

1870.		Fahr.	in.	gramme.
Sept. 28.	t of water and air	62°,	$b=30·45$	𝕿≏𝕷𝕭 + 0·30017
„ 29.	t „	60°,	$b=30·52$	𝕿≏𝕷𝕭 + 0·31986
			Mean	𝕿=𝕷𝕭 + 0·310

These results agreeing with 0·1 gramme, or $\frac{1}{100000}$th part, may be considered entirely satisfactory.

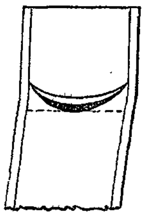
Verification of Standard Glass Burette Metric Measures of Capacity.

Standard glass burettes for delivering the specific measure of water.

These glass burette Metric measures, from a litre to a cubic centimetre, are intended to serve as standard measures for *delivering* the specified Metric measures of distilled water.

Under this condition, some of the water will always remain in the burette, and just in proportion to the possible variation of this quantity so left, will be the increased chance of error in the verification of these burette measures by weighing their contents of water, as compared with this method of verifying measures *holding* a specified quantity.

One great advantage of these glass burette measures consist in the fact that their contents of water can be very accurately ascertained, the delivering measure being defined by a fine line marked with a diamond around the neck of the burette in a plane perpendicular to the axis, and the height of the water in the narrow neck being defined by the lower edge of the *meniscus*, which is seen as a sharp black curved line when viewed against the light and a piece of thin paper is held behind it, presenting the following appearance:



The dotted line represents the defining line marked on the burette.

Another advantage is, that when the glass burette is placed on the stand for filling it, described in App. VI., p. 93, it can be readily filled with water up to the defining mark, and the measure of water can then be at once discharged into another measure required to be tested, or into a standard measure for the purpose of verifying the quantity of water delivered.

The question arises whether the most accurate measurement may be obtained from these glass burettes by discharging the whole quantity of water, leaving only what adheres to the glass, or whether the water should be discharged to a given line in the narrow tube below the body of the burette, as is the practice in graduated tubes for the smaller measures. The first-mentioned method has been adopted in the first instance for the standard burette

Appendix XII.—*continued.*

measures, as has already been stated in the account of the verification of the glass burette Imperial standard measures. But it will be desirable that experiments should be made with both methods, in order to determine the amount of dependence to be placed on their relative average accuracy.

The glass burette Metric measures, like those of the Imperial system, had been marked with provisional defining lines by Messrs. Griffin, and the first comparisons were made to test the accuracy of these lines, before having them permanently marked.

There is a duplicate series of these glass burette metric, distinguished as No. 2. The following comparisons have been made of the series No. 1.

First comparison of glass burette litre with 𝕷𝕭, by measurement of water.

Before proceeding to test these burettes by weighing their contents of water, a first comparison of the glass burette litre was made on 17th May 1870, by measuring its delivering contents of distilled water with the brass standard litre 𝕷𝕭.

Method of comparison.

The glass burette having been placed in the filling apparatus, the reservoir was filled with distilled water at the temperature of 61·2° F., the temperature of the air in the room being 64°; barometer at 30·28 in.

The burette stand was accurately levelled by means of the three adjusting screws at the foot of the apparatus, a delicate spirit level being used.

A small glass vessel for holding the water which might be required to make up the excess or deficiency of the capacity of the glass burette, for the purpose of ascertaining the exact weight of this quantity of water, was placed on the pan of balance No. 4, and counterpoised.

The measure of a litre at the temperature of 62° Fahr., according to Mr. Griffin's standard, was shown by a minute pin hole or point in a strip of paper affixed to the upper small tube of the burette, and the water from the glass reservoir was allowed to run into the burette until the bottom of the meniscus was level with the defining point. The contents of water were then discharged into the standard litre, which had been placed immediately below the burette, and found to be somewhat in excess of the capacity of the standard. The weight of the water in excess was ascertained to be 1·0334 gramme.

The glass burette was then refilled with water of the same temperature up to the same defining line. As nearly as possible the exact quantity of excess of water was allowed to drop into the small glass vessel, and its weight was verified. A second corrected defining point was then marked with a pin on the slip of paper attached to the small tube of the burette, and the standard litre having in the meantime been emptied and dried, the remaining water in the burette was run off into it, and found exactly to fill it.

The brass standard litre 𝕷𝕭 was determined at Paris to be a very little less (0·02588 grm.) than the true capacity of a litre, that is to say, a vessel containing a kilogram weight of distilled water at its maximum density, or at 4° C. (or 39·2° F.).

Correction for expansion.

After allowing for this deficiency, no further correction of the capacity of the litre marked on the glass burette appeared to be required than that due to the difference of cubic expansion of brass and glass for (61·2° — 39·2°) 22° F.

Formula for this correction.

The following formula for determining the amount of this correction, as well as that for calculating the ratio between the linear and the cubic expansion of substances, has been given by Professor Miller.

The cubic expansion is taken to be three times the linear expansion as follows:—

Let V_0, V_t be the volumes of any expansible substance at the temperatures 0°, t° respectively; e, the linear expansion of the substance for 1°. Then, a being the distance between any two definite points in the substance at 0° C., the distance between the points at t° C. will be $a\,(1+et)$.

$$\text{But } \frac{V_t}{V_0}=\frac{a^3(1+e\,t)^3}{a^3}=(1+et)^3=1+3et+3e^2t^2+e^3t^3.$$

Then, et being a small quantity, e^2t^2, e^3t^3 may in questions of the present kind be safely neglected, and we may put $\frac{V_t}{V_0}=1+3et$.

Again, for determining the difference between the expansion of a glass litre and a brass litre, let G_0, B_0 denote the capacities of two vessels of glass and brass respectively at 0° C.; G_t, B_t their capacities at t° C.; g, b, the linear expansions of the glass and brass respectively. Then we shall have

$$G_t=G_0(1+3gt),\ \text{and}\ B^t=B_0(i+3bt).$$

Let these two vessels be correct litres, L denoting a true litre. Then $G_0=L$, $B_0=L$, and therefore $G_t=L(1+3gt)$, $B_t=L(1+3bt)$, and $B_t-G_t=L(3b-3g)t$.

Cubic expansion of glass.

See Miller, p. 789.

The coefficient of cubic expansion of brass being taken at 0·00005166 for 1° C., that of glass has been taken at 0·00002658. This rate of expansion of ordinary white glass has been adopted after consultation with Professor Miller, being based on Regnault's determinations, and taking the expansion of quicksilver at ordinary temperatures (0° to 28° C.) to be 0·00017971 for 1° C. It is the mean between the rate for 0° to 10° = 0·00002628, and from 0° to 50° C. = 0·00002687. It may also be observed that it differs but little from the rate of the expansion of white glass as determined by Mr. Baily for the Standards Committee of 1843, viz. 0·00000890 × 3 = 0·00002670. (*See* p. 191.)

The relative coefficients of expansion of the brass litre and the glass burette are thus 0·00002870 and 0·00001477 for 1° Fahr., being an excess of expansion of the brass litre of 0·00001393, amounting for 22° F. to 0·0003064. This is equivalent in a litre to the weight of 0·3064 grm. of water, that is to say, at the temperature of 61·2° F., the true measure of a litre in the glass burette ought to be less than the capacity of the brass standard litre, by a quantity of water weighing 0·3064 grm. If this further quantity were therefore run out of the glass burette, the exact measure of the brass standard litre at 61·2° Fahr. would be left. If it were required to show the true measure of a litre on the glass burette at 62° F., which is the standard temperature of the Imperial measures of capacity, a further quantity of water weighing 0·0212 grm. (equivalent to a difference of 0·8° F.) should be discharged, making together a quantity of water weighing 0·3276 grm.

Results of this comparison of the glass burette litre.

But the capacity of the brass standard litre, 𝕷𝕭, is itself deficient by 0·0259 grm. weight of water. Consequently this quantity should be first added to the glass burette in order to show the true capacity of a litre according to the French standard temperature of 39·2° Fahr., and then by discharging the weight of 0·3276 grm. of water, the capacity of a litre at the British standard temperature of 62° Fahr. will be shown.

The true correction having been thus determined, the process before described was repeated on 25th May, the water being brought as nearly as possible to the previous temperature of 61·2° F.; and the defining points of the capacity of a litre at the temperature both of 39·2° and of 62° Fahr. were marked upon the glass burette, in order that the permanent lines might be engraved by Messrs. Griffin.

It follows that the weight of excess in water of Mr. Griffin's standard, beyond the true quantity, was (1·0334 — 0·0259+0·3276) 1·3353 gramme, or an excess of volume of 1·3351 cubic centimetre;

That for every 1° F. beyond 39·2°, the increased capacity of a brass litre is equal to an increased volume of water of the weight of 28·70 mgr., and that of a glass litre 14·77 mgr., being a difference of 13·93 mgr.;

That for every 1° C. beyond 4°, the increased capacity of a brass litre is equal to an increased volume of water of the weight of 51·66 mgr., and that of a glass litre 26·58 mgr., showing a difference of 25·08 mgr.;

That the excess of capacity of a brass litre at the British standard temperature of 62° Fahr., as compared with the French standard temperature of 39·2° Fahr. is 0·6543 cc., and that of a glass litre 0·3367 cubic centimetres.

And that the capacity of the standard brass litre 𝕷𝕭, being deficient 0·0257 cc. at 39·2° F., it will hold the exact quantity of a litre of water at 40° F.

Experiment of reducing the water in the litre burette from 62° to 32° F.

The following experiment with the Standard glass litre burette was made on 22nd July 1870:—

This glass litre burette has been stated to have two defining lines cut on its neck, about ¼ inch apart; the upper line purports to show the true measure of a litre at 4° C., or 39·2° F., the French standard temperature; the lower line shows the measure of a litre at 62° F., the British standard temperature. The burette having been filled with distilled water of the temperature of 62° F. as high as the upper defining line, it was surrounded with a thick belt of pounded ice, and left for about twenty minutes. During this period the water in the burette gradually sank until its height remained stationary at a point which was marked by two pin holes on a slip of paper attached to the neck of the burette. This point was nearly ⅛ inch below the lower defining line cut on the burette, and a horizontal line at the height of the pin holes would thus define the measure of a litre *of water* at 32° F., or 0° C. The pounded ice was then removed and the burette surrounded with water of the temperature of about 62°. The water in the burette gradually rose until it again remained stationary at a point so slightly above the upper line cut on the burette that it might be considered coincident with it.

During the experiment the delivery orifice of the burette was closed by shellac.

The difference between the lower defining line, cut on the neck of the burette, and the line of the pin holes marked

Appendix XII.—*continued.*

on the slip of paper was then ascertained, by weighing the water, to be equal to 3·75 grains of water at 62·0°, (= 243·823 mgr.) and the height from the upper line at 62°, to the line of the pin holes = 9 grains (583·19 mgr.)

In making this experiment care was taken to support the burette in a proper manner, lest the unequal expansions of the brass and glass should cause the burette to drop out of its brass socket.

The apparent anomaly is here presented, that whilst the defining line of the measure of the litre at 62° F., is $\frac{1}{4}$ inch *lower* than the line of the measure of a litre at 39·2° F.; yet on testing its contents of water, the reverse of this result is shown, the line of the surface of the water at 62° F. being about $\frac{5}{8}$ inch *higher* than at 32° F.

The explanation is, that in the first instance only the measure of the *capacity* of the glass burette is involved; in the second instance, not only the capacity of the burette, but also *its contents of water* at different temperatures.

As the glass burette expands by heat from 32° to 62° F., its capacity up to a given line must necessarily be greater, and the line marking its true measure of a litre must therefore be lower.

If, again, the water contained in the burette expanded equally with this glass vessel, the line of surface of the water would remain at the same height, notwithstanding the increase of temperature from 32° to 62°.

If the water expanded less than the glass burette there would be a greater capacity to hold relatively less volume of water, and the surface level of the water would consequently be lower at 62° than at 32°.

But if the water expanded more than the glass burette the opposite result would follow, and the given capacity of the measure not being able to hold the relatively increased volume of water, the level of the water at 62° would be higher than at 32°.

In either of the two last hypotheses the difference of the height of the water would be in the ratio of the expansion of the glass and of the water.

The result of the experiments shows the increased height of the water in the glass burette from 32° to 62°, equal to a weight of water of 583·19 mgr., or a volume of 583·19 cubic millimetres.

Taking the coefficient of cubic expansion of glass at 0·00001477 for 1° F., amounting for 30° F. to 0·0004431, a glass litre of the volume of 1,000 cubic centimetres at 32° would at 62° be of the volume of 1000·4431 cc.

Water is an exception to the very general law that bodies expand by heat at a nearly uniform rate of expansion. From 32° F., or freezing point, up to about 39·2°, water contracts instead of expanding, and at a decreasing temperature from 39·2° to 32° it expands as nearly as possible at the same rate as at an increasing temperature from 39·2° upwards.

Graham's Elem. of Chem., vol. i. p. 9.

According to Professor Miller's formula, already given, the expansion of a litre of water from 39·2° to 62° - - - - - - = 0·001120,
whilst its contraction from 32° to 39·2° = 0·000121

Net expansion = 0·000999,

or an increase of volume of 999 cc.

Hence the net increase of the volume of water in a glass burette = 999 cc. — 431 cc. or 568 cc., corresponding with the weight of 568 mgr. of water.

The slight difference between this computed result and the result of the actual experiment (583 cc.) may be accounted for either by an error in the observed temperature of the water equal to 0·3° F., or by the want of a precise knowledge of the rate of expansion of the glass or of the water.

Verification of glass burettes by weighing their contents of water.

An account will next be given of the verification of the whole series of Metric glass burette measures by the same mode as that adopted for the Imperial glass burette measures, viz., by weighing their delivering contents of distilled water against brass standard weights, equal to the legal weight, and making the necessary corrections for the difference of air displaced.

These corrections have been computed according to the Professor Miller's formula already described (p. 188) for brass Metric measures of capacity, substituting the coefficient of cubic expansion of glass for 1° C. at ordinary temperatures of atmospheric air = *0·00002658, for 0·00005166,* the *coefficient of cubic expansion of brass.*

Table of co rection for glass metri measures.

The following *is a comparative table of corrections for a* litre of water in a glass measure weighed against brass weights, *according to the German tables and according to* Professor Miller's formula, at the barometric pressure of 760 mm.; corrected to 0° C., and allowing for the average moisture of the air = $\frac{5}{8}$ of saturation; showing also the respective data upon which the tables have been computed:—

Comparative Table of Correction of the additional Weight required for a Litre of Water in a Glass Standard Measure weighed against Brass Weights, at the barometric Pressure of 760 mm., and the stated Temperature.

Temperature.	German Tables.		Professor Miller's Formula.	
	Correction.	Difference for 1° C.	Correction.	Difference for 1° C.
	gramme.		gramme.	
8° C =	0·942	28	1·005	35
9° =	0·970	41	1·040	48
10° =	1·011	55	1·088	59
11° =	1·066	67	1·147	77
12° =	1·133	80	1·224	87
13° =	1·213	93	1·311	100
14° =	1·306	105	1·417	112
15° =	1·411	116	1·523	125
16° =	1·527	128	1·648	135
17° =	1·655	140	1·783	146
18° =	1·795	151	1·929	157
19° =	1·946	160	2·086	168
20° =	2·106	172	2·254	176
21° =	2·278	180	2·430	190
22° =	2·458	192	2·620	200
23° =	2·650		2·820	
Data upon which these tables are computed:—				
Coefficient of cubic expansion for 1° C. of brass -	0·00005666		0·00001166	
" " " glass -	0·00003378		0·00002658	
" " " quicksilver	0·00018153		*0·00017971*	
" " " dry air -	0·003665		0·003656	
Weight of a litre of dry air *t.* 0° C., *b.* 760 mm. -	*1·29388*		*1·293893*	

Appendix XII.—*continued.*

As before mentioned, 1·4 mm. may be added or subtracted for every 1 mm. of pressure above or below 760 mm.

Weighings of standard Metric glass burettes.

The standard Metric glass burettes were verified in the following manner :—

The burette was filled with distilled water, and emptied, being allowed to drain for five minutes, when its orifice was stopped with shellac. The burette thus wetted was placed in the left-hand pan of the balance, together with brass metric weights equivalent to the weight of its legal contents of water, and these were counterpoised by a duplicate burette measure and with brass weights. After making and noting the requisite weighings, the equivalent brass weights were removed from the left-hand pan, and the burette was filled with distilled water up to its defining mark and again placed in the same scale, together with the additional weight required to make it equal to the counterpoise weight remaining in the right-hand scale. This additional weight is approximatively shown by the preceding table of corrections.

The following comparisons were thus made :—

Comparisons of Metric Glass Burettes, No. 1.

No.	Date of Comparison.	Compared Burettes filled with Water, &c.	Comparing Standard Weights.	Difference in Divisions.	Balance used.	Value of One Division of Balance.	Difference in Milligrams.
	1870.					mgr.	mgr.
(1)	October 12 -	1 litre + 1·10045 grm. -	Kilogram, 𝕶 -	+ 0·75	No. 1 -	3·15	+ 2·36
(2)	July 2 -	500 c.c. - - -	500 gramme, 𝕮 -	+ 2·25	„ „ -	11·82	+26·60
(3)	„ 21 -	200 c.c. - - -	200 „ 𝕸	− 6·92	„ „ -	3·81	+26·37
(4)	„ „ -	100 c.c. - - -	100 „ „	− 1·45	„ 5 -	0·19	+ 0·28
(5)	„ „ -	50 c.c. - - -	50 „ „	+22·50	„ 4 -	0·03	+ 0·79
(6)	„ 22 -	20 c.c. + 0·130 grm. -	20 „ „	+27·12	„ 5 -	0·19	+ 5·17
(7)	„ „ -	10 c.c. + 0·075 „ -	10 „ „	−10·22	„ 4 -	0·08	− 0·81
(8)	„ „ -	5 c.c. + 0·132 „ -	5 „ „	+26·80	„ 5 -	0·21	+ 5·6
(9)	„ „ -	2 c.c. + 0·050 „ -	2 „ „	− 2·85	„ 4 -	0·02	+ 0·5
(10)	„ „ -	1 c.c. + 0·005 „ -	1 „ „	+ 9·27	„ „ -	0·03	+ 0·34

Results of the above Comparisons.

No.	Standard compared.	Weight of Water contained in compared Glass Burette.	t.	b.	Correction for Temperature and Barometric Pressure.	Ascertained Error of Burette.
		grm.	°	mm.	grm.	grm.
(1)	1 litre No. 1 -	998·912	14·72 C.	744·46	+1·470	+0·382
(2)	500 c.c. „ -	500·027	17·91	761·70	+0·960	+0·987
(3)	200 „ „ -	200·026	15·75	764·85	+0·325	+0·351
(4)	100 „ „ -	100·000	12·75	764·85	+0·130	+0·130
(5)	50 „ „ -	50·000	16·05	764·85	+0·084	+0·084
(6)	20 „ „ -	19·875	16·72	765·89	+0·035	−0·090
(7)	10 „	9·992	16·66	765·89	+0·018	−0·009
(8)	5 „ „ -	4·872	16·66	765·89	+0·009	−0·119
(9)	2 „ „ -	1·950	16·11	765·89	+0·003	−0·047
(10)	1 „ „ -	0·995	16·11	765·89	+0·002	−0·003

As the defining marks on the necks of the burette measures containing less than a litre were provisional only, the requisite corrections of these marks have been made after, by adding or diminishing the proper quantity of water, with a view to the defining lines being permanently engraved, after they shall have been definitively determined.

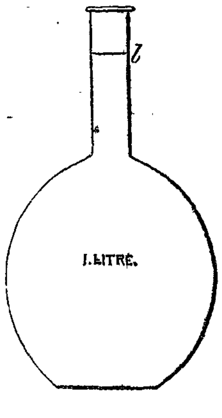
It would appear from this mode of verifying the litre glass burette that its capacity is 0·382 cc. in excess, whilst by measurement with the brass litre 𝕷𝕭 it was considered as correct, thus showing a discrepancy of 0·382 cc. in the two results.

As a further test, the glass burette litre has been compared by measuring its delivering contents with a litre glass flask, after the capacity of this flask had been verified by weighing its contents of water.

Verification of litre glass flask.

The litre glass flask furnished by Messrs. Griffin, and bearing their defining line at 15° C. is made of thin white glass, and is of the following form :—

Litre Flask, ¼ of actual height and diameter.



Total height = 230 mm.
Greatest diameter = 120 „
Height of neck = 80 „
Diameter of neck = 20 „
l is the defining line.

Appendix XII.—*continued.*

This flask was verified by first counterpoising it with a similar glass flask, and then by weighing its contents of water to the defining line against the kilogram 𝔎, in Balance No. 2, as follows:—

No.	Date of Comparison.	Weighings.	Difference of Weighings.
	1870.	grm.	
(1)	October 14 -	Litre flask filled with water ≏ counterpoise and 𝔎 + 2·400	±0·0
(2)	„ 17 -	„ ≏ „ + 2·579	±0·0

Reductions of Comparisons.

No.	Result of Weighings.	t. of Water.	Corrected b.	Correction of Weight to be added.	Corrected Weight.	Error.
	grm.	°	mm.	grm.	grm.	grm.
(1)	Contents of water in litre flask = 1,002·400	13·94 C.	763	1·450	1,003·850	+3·850
(2)	„ „ = 1,002·579	15·28	750·3	1·549	1,004·128	+4·128
				Mean -	1,003·989	+3·989

Comparisons of the several litre measures with each other.

The capacity of the litre flask up to the marked line being thus found nearly 4 cc. in excess, and this excess of capacity was checked by pouring the contents of water in the flask into the standard brass litre 𝔏𝔅 when wetted, which was over filled by about the specified quantity. The glass flask being again filled to its defining line, the measure of 4 cc. of water was taken from it by means of a graduated cubic centimetre tube, which had been accurately verified, and a second provisional defining line was marked upon the neck of the flask 6 mm. lower than the previous mark.

A comparison was then made between the corrected capacity of the litre flask and 𝔏𝔅, by measurement of the contents of water poured from the flask into 𝔏𝔅, this brass measure having previously been wetted. The temperature of the water being 15·28°, the increased capacity of the brass measure beyond that of the glass flask was equal to 0·358 cc. (14·28° × 25·08 mgr.) It was found that very nearly this quantity of water was required to complete the filling of 𝔏𝔅, after the contents of the flask had been poured into it, thus satisfactorily confirming the accuracy of the corrected capacity of the glass flask.

A similar satisfactory comparison was then made of the glass burette litre by delivering its contents of water as measured from the lower or proper defining line on its neck into the litre glass flask, which they filled very nearly up to the corrected defining line. The discrepancy shown by the weighing on 12th October (p. 194) may thus be disregarded.

Constru tion of c plete se of stand glass fla of both Metric Imperia measure

It thus appears both practicable and expedient to construct and verify a series of standard liquid measures of capacity in the form of glass flasks, with the defining line marked on the neck of the flask. Greater accuracy may be obtained by having the neck of the flask of less diameter than that above described, and not exceeding half an inch, or about one-tenth of the diameter of the flask.

With this view Messrs. Griffin have been directed to construct a complete series (in duplicate) of glass-measuring flasks from a litre to a cubic centilitre, as well as a similar series of glass flasks of Imperial measure of the same denominations as the standard glass burette measure already provided (*see* App. VI., p. 93). There appears to be some difficulty in getting these glass flasks constructed in this country, and it has been found necessary to order them to be made in Germany.

When these new glass-measuring flasks shall have been accurately verified, it is proposed to re-verify all the glass burette measures by delivering their contents of water into the corresponding glass flasks, after these last shall have been accurately verified by weighing their contents of water. By taking the mean of several such comparisons of these burette delivering measures, in which a more or less variable quantity of water must always be left, their more accurate verification may be effected. Meanwhile, it may be considered that the defining lines now marked on all these new standard glass burettes are only provisional.

PART 4.—Corrected Imperial Equivalents of the Litre and of the Metre.

Corrected imperial equivalents of the litre and of the metre.

In concluding this Paper on the official standard metric weights and measures, it remains to point out that the adoption of new and more accurate tables of corrections for temperature and barometric pressure, when weighing in air the water contents of metric measures of capacity, renders it necessary to make a slight correction in the equivalent in imperial measure of the litre, viz., 0·2202443 gallon, as stated in Appendix VI. to the Second Report of the Standards Commission (p. 129).

For the computation of this equivalent, the weight of a litre of water, weighed in a brass standard measure against brass weights, in air at the temperature of $16\frac{2}{3}$° C. (62° F.), and the normal barometric pressure of 760 mm. at 0° C. (29·921 inches), was taken to be 999·012 grammes, being computed from the correction for the weight to be added according to M. Corioli's table, which is now superseded, viz., 0·988 gramme.

The correction according to the several more recent table of corrections stated at p. 193, is as follows :—

	gramme.
M. Tresca's French table - - -	1·283
Dr. Förster's German table - - -	1·233
Table now computed from Professor Miller's formula - - - - -	1·320
Mean -	1·279

Until a common table of corrections can be agreed upon for the several countries, it appears desirable to take this mean correction for the purpose of computing a more accurate equivalent of the litre in imperial measure.

To determine this equivalent for commercial purposes, it is obvious that the capacity of the metric measure as well as of the imperial measure must be taken according to the conditions in which each is commonly used, that is to say, in ordinary air; thus carrying out the principle adopted by the Commission, as stated in App. XV. Therefore in air t=62° F., b = 30 inches, the weight of water in the imperial gallon being 10 lbs., and that in the litre being 998·721 grammes or 2·20180 lbs., it follows that the corrected metric equivalent of the imperial gallon is 4·54173 litres, and the corrected equivalent in imperial measure of the litre is 0·22018 gallon.

It has been already shown (p. 186) that whilst no correction appears to be required in the existing legal scientific equivalent in Imperial measure of a standard metre at its true length at 32° F., viz., 39·37079 inches, yet that the Imperial equivalent of a *commercial* metre, for which, when in ordinary use, no correction is ever made for increase of length by expansion, would be more truly represented by 39·382 inches.

It is intended therefore in preparing the new tables of legal equivalents of imperial and metric weights and measures for commercial purposes, to be appended to the proposed bill for amending and consolidating the laws relating to weights and measures, to base the imperial equivalents of metric measures of length on the metre =39·382 inches, and the imperial equivalents of metric measures of capacity on the litre =0·22018 gallon; the equivalent of the kilogram in imperial weight remaining at 15432·34874 grains, as determined by Professor Miller in the year 1844, and now adopted in France.

H. W. CHISHOLM,
Warden.

Standards Department,
28th November 1870.

APPENDIX XIII.

PAPERS RELATING TO THE INTERNATIONAL STANDARDS COMMISSION AT PARIS, FOR THE CONSTRUCTION AND VERIFICATION OF PRIMARY INTERNATIONAL METRIC STANDARDS.

CONTENTS.

Page
1. Copy of Resolution of the International Geodesical Conference at Berlin, in 1867, on the establishment of an International system of weights and measures, and construction of International Metric standards - 199
2. Report of Commission of the Academy of Sciences, at St. Petersburg, dated 26th May 1869, on the appointment of an International Commission, for the construction of International Metric standards - „
3. Report of Commission of the Academy of Sciences at Paris, on the metric system, and primary metric standards. (From Comptes Rendus des Séances, 23rd August 1869) - - - - 201
4. Report to the Emperor by the French Minister of Commerce, &c., and appointment of the French members of the Metric Commission, dated 1st September 1869 - - - - 202
5. Letter from M. De Jacobi to M. Dumas, Secretary to the French Academy, dated 12th September 1869 - 204
6. Paper read before the French Academy, by M. De Jacobi, 19th October 1869 - - - - „
7. Translation of reports from the Standards Commission at Berlin, 29th December 1869, &c. - - 205
8. Letter from the French Ambassador at London, to the Earl of Clarendon, Foreign Secretary of State, dated 19th November 1869, inviting representatives from the United Kingdom to take part in the International Standards Commission at Paris - - - 206
9. Reference to minutes of proceedings of the Standards Commission of 21st December 1869, and 2nd April 1870, on the appointment of delegates to Paris, 7th May 1870 - - - - - - - „
10. Treasury to Board of Trade, enclosing copy of following letter - - - - - - - „
11. Treasury to Foreign Office, appointing the Astronomer Royal and Professor W. H. Miller, as delegates from this country to the conference at Paris, dated 7th May 1870 - - - - - - „
12. Minutes of the Warden of the Standards, the Astronomer Royal, and Professor W. H. Miller, on the question of appointing the Warden of the Standards as a third delegate to the Conference, dated May 1870 - 207
13. Treasury to Board of Trade. Appointment of Mr. Chisholm as third delegate to Conference at Paris, dated 30th May 1870 - - - - 208

1. COPY of RESOLUTION (6) of the INTERNATIONAL GEODESICAL CONFERENCE, held at BERLIN, from 30th September to 7th October 1867, upon the question of the COMPARISON and VARIATION of STANDARDS. (From p. 25 of Les Mondes, Revue Hebdomaire des Sciences 2^e Janvier 1868.)

Extrait des Procès-verbaux.

Les membres présents étaient: MM. le Docteur Bauernfeind, Dr. Louis Seidel, Général Simons, Dr. Hansen, Dr. Hügel, Lieut.-Général Ricci, Colonel de Vecchi, Dr. Donati, Paschen, Kaiser, Lieut.-Colonel de Ganahl, Dr. Herr, Dr. Förster, Dr. Peters, Dr. Wittstein, Dr. Schering, Dr, Boersch, de Struve, Major-Général Försch, Dr. Wiesbach, Dr. Brunhs, Nagel, Lindhagen, Dr. Fearnley, Dr. Hirsch, Dr. Baur.

Les membres invités étaient: MM. le Docteur Mühler, Dr. Auwers, Dr. de Brandt, Colonel de Chauvin, Dr. Dove, Hagen, de Hesse, Dr. Sadebeck, de Morozowicz, de Sidow, Dr. Brix, Dr. Kämtz, Dr. Sartorius von Waltershausen.

Resolution 6. Comparaison des Étalons.

1. On confirme la résolution prise, il y a trois ans, par laquelle la Conférence a reconnu la nécessité de comparer les étalons et les régles dont on s'est servi pour la mesure des bases dans les différents pays. Pour éxécuter ces comparaisons, on demande la construction de deux comparateurs, l'un pour les étalons, et l'autre pour les régles des appareils de base; ces comparateurs doivent être construits de façon à permettre la comparaison des étalons à bout et à trait, et la détermination des coefficients de dilatation.

2. Une Commission spéciale est chargé d'établir les principes à suivre dans ces comparaisons et pour la construction des comparateurs. La Commission nommée dans ce but, il y a trois ans, doit être complétée par six nouveaux membres, au moins, appartenant aux pays qui prennent part à l'Association géodésique; la Commission permanente est chargée de désigner ces nouveaux membres.

3. La Commission recommande à la Conférence de provoquer des recherches ultérieures sur la variabilité, avec le temps, des coefficients de dilatation des régles et étalons; elle désire qu'on y ait égard eventuellement dans la construction de nouveaux étalons prototypes.

4. Il est dans l'intérêt des sciences en général et de la géodésie en particulier, qu'un système unique de poids et mesures, avec subdivisions décimales, soit adopté en Europe.

5. Puisque parmi toutes les mesures qui peuvent entrer en question, le mètre a pour lui la plus grande probabilité d'être accepté généralement, la Conférence se prononce pour le choix du système métrique.

6. On recommande d'accepter le système métrique, là où il est introduit, sans changements et en maintenant partout la subdivision décimale. En particulier on se prononce contre l'introduction du pied métrique.

7. Afin de définir l'unité commune de mesure pour tous les pays de l'Europe et pour tous les temps aussi exactement et aussi invariablement que possible, la Conférence recommande la construction d'un nouveau mètre prototype européen. La longeur de ce mètre européen devrait différer aussi peu que possible de celle du mètre des Archives de Paris, et doit en tout cas lui être comparée avec la plus grande exactitude. Dans la construction du nouvel étalon prototype, il faut avoir surtout en vue la facilité et l'exactitude des comparaisons nécessaires.

8. La construction du nouveau mètre prototype ainsi que la confection et la comparaison de ses copies, destinées aux différents pays, devraient être confiées à une Commission Internationale, dans laquelle les états intéréssés seraient répresentés.

9. La Conférence se prononce pour la création d'un bureau international des poids et mesures.

10. La Conférence recommande à MM. les délégués de porter ces résolutions à la connaissance de leurs gouvernements, et la Commission permanente est chargée de veiller autant que possible à leur exécution.

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2. COPY of REPORT of COMMISSION of the ACADEMY of SCIENCES at ST. PETERSBURG, dated 20th May 1869, on the APPOINTMENT of an INTERNATIONAL COMMISSION for the CONSTRUCTION of INTERNATIONAL METRIC STANDARDS.

Confection des étalons prototypes des poids et mesures métriques.

RAPPORT de la COMMISSION nommée par la CLASSE PHYSICO-MATHÉMATIQUE de L'ACADÉMIE des SCIENCES de ST. PÉTERSBOURG.

Commissaires—MM. STRUVE, WILD, JACOBI, rapporteur.

Lu dans la séance de la Classe du 20 mai 1869.

La Commission nommé dans la séance du 8 avril 1869 pour examiner la proposition de M. Jacobi concernant la nécessité de soumettre à une Commission internationale plusieurs questions qui se rapportent à la confection des étalons prototypes des poids et mesures, adhère, quant au fond, à la proposition mentionnée et a l'honneur de soumettre à la Classe les considérations suivantes.

En vue des progrès faits dans les dernières années par rapport à l'introduction plus générale du système métrique et en prévision de ce que l'adoption de ce système par les

Appendix XIII.—*continued.*

savants de tous les pays ne peut manquer de se réaliser dans un avenir prochain, il est urgent de soumettre à un examen la base sur laquelle l'unité unique et universelle des poids et mesures devra être établie définitivement. En effet, un établissement solide de cette unité est d'autant plus important qu'il n'y s'agit pas seulement du consentement de toutes les nations dans le présent, mais de la garantie qu'un avenir même éloigné ne soit réduit à renier l'héritage que nous avons voulu lui léguer. Une pareille pensée avait présidé aux travaux à jamais mémorables, entrepris en France dans le but de procurer au monde une mesure universelle, invariable et susceptible d'être reproduite “ quand “ même, comme l'a dit Arago, des tremblements de terre, “ des cataclysmes épouvantables, viendraient à bouleverser “ notre planète et à détruire les étalons prototypes gardés aux “ archives.” Aujourd'hui nos appréhensions à cet égard ne sont pas assez fortes pour nous faire plaider la cause des mesures soit-disant absolues et naturelles. L'insuffisance et l'inexactitude relative des ces mesures ont été généralement reconnues et démontrées jusqu'à l'évidence par l'argumentation puissante et péremptoire du célèbre Bessel, de manière qu'il est impossible que dorénavant le monde savant revienne à la recherche de pareilles mesures. Aussi est-il démontré que l'étalon du mètre gardé aux archives de France n'est pas la dix-millionième partie du quart du méridien; que sa longueur en est seulement une partie quelconque, dont le rapport n'est défini et valable que pour une certaine époque; et auquel il faut appliquer des corrections à chaque nouveau progrès réalisé dans notre connaissance de la figure de la terre. L'étalon en question a donc dû renoncer au caractère d'une mesure naturelle qu'on lui supposait posséder à son origine et il n'est aujourd'hui qu'une mesure arbitraire et de convention. Cependant il est impossible de méconnaître que la fiction qui lui a servi de base a puissamment contribué à étendre son usage, en facilitant son adoption par d'autres nations. En effet le mètre doit une grande partie de son prestige à l'idée flatteuse pour l'orgueil humain, de pouvoir rapprocher les mesures dont l'homme fait journellement usage aux dimensions du globe qu'il habite. Il est certain que l'amour propre national aurait toujours été un obstacle à l'adoption générale, soit du pied royal de France, soit du standard yard d'Angleterre, ou du pied du Rhin, ou d'une aune quelconque. On se serait tout au plus contenté d'appliquer les principes du système métrique, ses divisions décimales et la parfaite logique de son organisation aux poids et mesures; mais leur diversité n'aurait pas disparu.

Ainsi, par des raisons scientifiques et d'opportunité trop souvent discutées pour qu'il puisse être nécessaire d'y revenir ici, toutes les nations civilisées sont tacitement d'accord pour reconnaître au système métrique français les avantages d'un système universel des poids et mesures de l'avenir, et pour considérer les étalons déposés aux archives de France comme des étalons prototypes de ces mesures. Les Gouvernements obligés, par des nécessités scientifiques ou pratiques, à se procurer des copies exactes des étalons prototypes métriques pour y pouvoir rapporter leurs propres mesures, ne peuvent obtenir ces copies à moins de demander le consentement des autorités de France et d'envoyer à cet effet des délégués à Paris. Il est vrai que ce consentement n'a jamais été refusé et a été même accordé avec toute la prévenance possible, sous condition toujours de se servir des comparateurs disponibles au Conservatoire Impérial des arts et métiers, et de ne pas prendre ces copies directement des étalons des archives, mais des étalons du Conservatoire confectionnés en même temps, avec les mêmes matières et par les mêmes artistes que ceux des archives. De cette manière un assez grand nombre de ces copies, faites pour la plupart avec beaucoup de soins, sont répandues aujourd'hui dans plusieurs parties du monde; elles peuvent satisfaire parfaitement, il faut l'avouer, aux besoins du commerce et de l'industrie.

Cependant on ne saurait méconnaître que cette manière de procéder isolement et d'abandonner une aussi importante affaire presqu'au hazard, n'est pas à la hauteur de la tâche qu'il s'agit d'accomplir. En effet, toutes les copies dont nous venons de parler, et qui sont destinées à servir de prototypes pour les différents pays, ont été faites indépendamment l'une de l'autre, sans avoir rien de commun entre elles, ni par la matière dont elles ont été confectionnées, ni par les méthodes et les instruments à l'aide desquels elles ont été comparés; ni par la température à laquelle cette comparaison a été faite; ni par le coëfficient de leur dilatation; non plus que par leur construction et leurs dimensions, que par les réglements concernant leurs erreurs tolérables et par la manière dont les étalons sont conservés. On conçoit que ce manque d'uniformité entre les différents prototypes ne peut manquer de faire naître des incertitudes et des diversités regrettables aussi bien au point de vue des exigences de la science et de la technique, que des nécessités du commerce et de l'industrie. Ces diversités qui se font sentir même à l'époque actuelle et qui seront encore plus sensibles à l'avenir, ne manqueront pas de compromettre l'uniformité tant désirée et l'œuvre dont notre époque pourrait se faire une gloire. Il est à prévoir que dès qu'on ne procède pas dans cette affaire avec toute la solidité convenable, qu'on n'emploie pas dans la confection des étalons prototypes une rigueur extrême, et tous les moyens dont la science dispose aujourd'hui pour rendre ces étalons aussi uniformes que possible, qu'on se contente au contraire de demi-mesures et de l'admission d'erreurs tolérables sur lesquelles chaque Gouvernement aurait ses différentes appréciations au point de vue du commerce international, il est à prévoir qu'il y aura à l'avenir aussi bien des mètres des Etats-Unis, de l'Angleterre, de la Confédération de l'Allemagne du Nord, de l'Autriche, de la Suisse, du Danemarc etc., aussi bien qu'il y a aujourd'hui des pieds différents et des différentes aunes dans ces pays.

Les inconvénients que Votre Commission vient de signaler n'ont pu échapper ni aux individus, ni aux associations ou corporations savantes que se sont occupées de la question de l'uniformité des poids et mesures. C'est ainsi que parmi les 5 résolutions formulées en faveur du système métrique adoptées unanimement dans la sixième séance du 5^{e} Congrès international de Statistique, la seconde résolution porte:

> “ Le soin de rédiger et de mettre à exécution les prescriptions à suivre dans la construction des étalons et du système même est confié à une commission internationale qui se chargera également de la correction des petits défauts scientifiques de ce système.”

Dans la deuxième séance de Conférence géodésique internationale réunie à Berlin en 1867 cette assemblée s'est prononcée plus positivement encore à cet égard. Parmi les dix propositions formulées en faveur du système métrique et dans le but de parvenir à une uniformité des poids et mesures aussi complète que possible, les 7^{e} et 8^{e} propositions portent:

7^{e} proposition:

> “ Afin de définir l'unité commune de mesure pour tous les pays de l'Europe et pour tous les temps aussi exactement et aussi invariablement que possible, la Conférence recommande la construction d'un nouveau mètre prototype européen. La longueur de ce mètre européen devrait différer aussi peu que possible de celle du mètre des archives de Paris et doit en tout cas être comparée avec la plus grande exactitude. Dans la construction du nouveau étalon prototype, il faut avoir surtout en vue la facilité et l'exactitude des comparaisons nécessaires.”

Et la 8^{me} proposition:

> “ La construction du nouveau mètre prototype ainsi que la confection et la comparaison de ces copies destinées aux différents pays, devraient être confiées à une Commission Internationale dans laquelle les États intéressés seraient représentés.”

Votre Commission, en s'appuyant sur ces manifestations éclatantes de l'opinion des personnes les plus compétentes dans cette matière, est unanimement d'avis que la question de l'uniformité des étalons est de la plus haute importance; qu'elle est la base uniquement propre pour y établir un système universel des poids et mesures aussi stable et parfait que possible; qu'un tel résultat ne peut pas être obtenu par des travaux isolés, quelque méritoires qu'ils soient; qu'on ne pourra atteindre ce but que par des travaux communs, organisés convenablement; qu'enfin, il est indispensable d'attirer sur cette affaire toute l'attention des Gouvernements, qui nécessairement y devraient prêter leur concours par la nomination d'une Commission Internationale, composée de déléguées de tous les pays, et à laquelle serait confiée la confection des étalons prototypes des mesures de longueur et de capacité, et des poids.

Il est évident qu'une pareille Commission pourra d'autant mieux accomplir sa tâche que le nombre d'étalons prototypes à confectionner de manière à s'approcher le plus près possible de l'identité, sera plus grand.

En effet une telle condition est indispensable. Ce n'est qu'une fabrication faite sur une large échelle qui permettra d'employer tout ce que la science, de concert avec la technique et la mécanique des instruments de précision, pourra produire de plus accompli.

Il convient de relever en même temps, ce qui est important au point de vue pratique et économique, que les étalons fabriqués dans ces conditions pourront être fournis

Appendix XIII.—*continued.*

à des prix beaucoup plus modérés, que si on les confectionnait séparément.

Votre Commission a l'honneur de proposer:

1^{e} que l'Académie emploie son autorité pour solliciter S. E. Monsieur le Ministre de l'Instruction publique d'intervenir auprès du Gouvernement Impérial pour que tous les Etats étrangers soient invités à envoyer des délégués pour former une Commission Internationale qui devra se réunir dans une des capitales encore à désigner, dans le but de régler la confection des étalons prototypes métriques et de créer une unité de mesure véritablement universelle et effectivement internationale.

2^{e} que M. Jacobi soit chargé de faire valoir à l'occasion de la réunion de l'Association Britannique pour l'avancement des sciences à Exeter; les principes qui viennent d'être établis dans le présent rapport et l'urgence de l'adoption universelle du système métrique par les savants de tous les pays.

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3. REPORT of COMMISSION of the ACADEMY of SCIENCES at PARIS, on the METRIC SYSTEM and PRIMARY STANDARDS. (From *Comptes Rendus des Séances*, 23rd August 1869.)

RAPPORT sur les PROTOTYPES du SYSTÈME MÉTRIQUE: le mètre et le kilogramme des Archives.

(Commissaires: MM. ÉLIE DE BEAUMONT, MATHIEU, MORIN, REGNAULT, LE VERRIER, FAYE, DUMAS, rapporteur.)

L'ACADÉMIE après avoir pris connaissance des propositions faites à l'Académie de Saint Pétersbourg, au sujet des étalons des poids et mesures a décidé qu'une Commission serait chargée d'examiner la question et de lui en donner son avis. Cette Commission vient remplir son devoir.

Un système métrique général propre à réunir l'assentiment de toutes les nations était desiré depuis longtemps, lorsque l'Assemblé constituante, s'inspirant des vues de l'ancienne Académie des Sciences chargea cette compagnie d'en tracer le plan.

Le travail, commencé en 1790, sur la proposition de M. de Talleyrand, et poursuivi au milieu des circonstances les plus difficiles, s'achevait la 4 messidor An vii par la présentation à la barre des deux conseils des étalons prototypes du mètre et du kilogramme contrôlés et adoptés par une Commission Internationale.

La France au début même de cette entreprise, avait appelé le concours des autres nations. Si elle s'etait mise à l'œuvre et si elle l'avait accomplie sans attendre ce concours, elle avait évité avec soin tout ce qui pouvait donner le plus léger prétexte au reproche d'avoir voulu affecter une sorte de prééminence.

Aussi les premiers Commissaires de l'Académie avaient-ils le droit de dire que si la mémoire de ces travaux venait à s'effacer, si les résultats seuls en étaient conservés, ils n'offraient rien qui pût servir à faire connaître quelle nation en a conçu l'idée, en a suivi l'exécution.

Au procès-verbal de dépôt des étalons du mètre et du kilogramme confié aux Archives, on compte les signatures de neuf délégués étrangers, parmi les vingt-deux signataires, où figurent d'ailleurs les artistes, le garde-général et le secrétaire.

Le mètre avait été adopté sur le Rapport définitif du délégué de la Hollande, Van Swinden, et le kilogramme sur celui de Trallés, délégué de la Suisse.

L'Académie sait que parmi les trente-deux personnages, la plupart illustres, qui ont coopéré aux premiers travaux rélatifs à la determination du mètre et du kilogramme, on compte les savants les plus autorisés non seulement par leur génie, mais aussi par leur rare bon sens; les artistes les plus dignes de confiance, non seulement par leur esprit inventif, mais aussi par une main d'œuvre dont la précision n'a jamais été surpassé.

Laplace and Lagrange y représentent la géométrie; Borda, Delambre, Méchain, Prony, et plus tard Biot and Arago, la géodésie; Lavoisier, les sciences physiques; Lenoir and Fortin, la construction des instruments.

La tradition fait remonter à Laplace une grande part dans la conception du système; elle attribue à Borda le mérite du plan des opérations géodésiques, et à Lavoisier la responsabilité de la marche adoptée pour la détermination du kilogramme.

Les Documents établissent la part qui revient dans l'exécution à Delambre, Méchain, Lenoir and Fortin.

Alors même que les procès-verbaux et les Rapports définitifs ne le démontreraient pas, la repartition des premières copies authentiques du mètre et du kilogramme prototypes indiquerait, à elle seule, sur quel pied d'égalité les nations étrangères et la France furent placées pendant ce travail et au moment de sa conclusion. En effet, douze exemplaires du mètre ayant été comparés au prototype et leur exactitude ayant été reconnue, ils furent distribués sans distinction, pour leur divers Etats, entre les Commissaires, au moment de clore leur travail, et les étrangers en reçurent dix.

La précision des opérations et leur caractère international ont été souvent confirmés depuis cette époque: en premier lieu, par des arrêtés du Gouvernement français, qui ordonnent la construction de nouveaux étalons du mètre et du kilogramme destinés à l'Observatoire et au Conservatoire des Arts and Métiers; en second lieu, par les opérations répétées, qui ont été effectuées pour fournir à divers Gouvernements des copies authentiques de ces deux mesures; enfin par une suite d'expériences auxquelles l'un de nous, M. Regnault, a consacré près d'une année, et qui avaient pour objet la discussion des méthodes et la construction des instruments à l'aide desquels on peut procéder avec certitude à la vérification des étalons des mesures et poids métriques.

Cependant la Conférence géodésique internationale réunie a Berlin en 1867 proposait, ainsi que le rappelle M. Jacobi, la construction d'un nouveau mètre prototype Européen, dont la longeur devrait différer aussi peu que possible de celle du mètre des Archives de Paris, et dans la construction duquel on aurait surtout en vue la facilité et l'exactitude des comparaisons nécessaires.

La construction du nouveau mètre prototype et la comparaison des copies destinées aux divers Etats seraient confiées à une Commission internationale.

A ces prescriptions M. Jacobi ajoute celle qui était formulée par le Congrès internationale de Statistique, qui voulait que cette Commission fût chargée en outre de la correction des petits défauts scientifiques du système.

De son côté, le Gouvernement français n'était pas demeuré indifferent à ces manifestations, et il avait chargé, sous la présidence de notre confrère M. le Maréchal Vaillant, une Commission, formée de membres de l'Académie et de représentants du Bureau des Longitudes, de lui donner son avis.

Cette Commission a terminé depuis longtemps la première partie de sa mission. Elle a adressé son Rapport à M. le Ministre d'Instruction Publique, et elle est demeurée à sa disposition pour l'exécution des opérations qu'elle propose, quand elles auront reçu l'approbation du Gouvernement. En attendant puisque la question semble destinée à faire ailleurs l'objet de discussions publiques, l'Académie pensera sans doute, avec la Commission qu'elle a chargée de l'examiner, qu'une déclaration de sa part est devenue nécessaire. Les Commissaires n'avaient pas besoin d'une longue délibération pour la preparer. Ces matières n'ont jamais cessé de les occuper, et elles sont devenues depuis deux ans, pour chacun d'eux, l'objet d'une étude approfondie, ayant été consultés à divers titres par l'autorité sur les difficultés qu'on lui signalait.

Trois questions sont posées: 1° le mètre prototype des archives répresente-t-il l'unité fondamentale du système métrique? 2° le kilogramme des archives represente-t-il l'unite de poids? 3° peut-on donner aux Gouvernements qui veulent adopter le système métrique le moyen de se procurer avec certitude des étalons du mètre et du kilogramme absolument conformes à ces deux unités?

Les membres de votre Commission n'ont jamais hésité à ce sujet, et leurs nouvelles conférences n'ont fait que les fortifier dans leur sentiment.

Le mètre et le kilogramme des archives sont des prototypes représentant, l'un l'unité fondamentale au système métrique, l'autre l'unité de poids.

Ils doivent être conservés comme tels, sans modification. En effet, ce serait bien mal connaître la penseé des savants illustres qui ont préparé et exécuté le travail relatif à la determination des bases du système métrique, que de supposer qu'ils aient considéré la distance du pôle boréal à l'equateur comme invariable sur tous les méridiens et la meridienne qui traverse la France comme representeé, elle-même, par des chiffres absolus.

La valeur du mêtre changerait donc avec les pays et les époques, si on n'acceptait pas comme unité fixe la valeur qui lui a été attribuée par leurs premières opérations. Les changements, il est vrai, resteraient absolumment insensibles dans la pratique; ils auraient, néanmoins, pour effet de jeter le trouble dans les travaux scientifiques, et d'exiger, pour leur comparaison de nation à nation, ces calculs de conversion qu'on a voulu éviter par l'adoption d'un type commun.

La France est d'autant moins libre de considérer la valeur du mètre dont elle a gardé le prototype, comme destinée à subir les variations qui seraient indiquées par les nouvelles mesures du méridien qu'on pourrait exécuter, qu'elle n'a pas adopté seule cette unité fondamentale; que, comme nous l'avons rappelé, diverses nations ont concouru par leurs délégués au travail de sa Commission primitive des poids et mesures, et que depuis le commencement du siècle beaucoup d'autres ont adopté le système métrique et fait exécuter des étalons authentiques de son unité. A l'égard du kilogramme, on lui reproche de représenter le poids du litre d'eau au maximum de densité, et non le litre d'eau à zéro, par exemple, quantité mieux définie. Il est bien connu que les expériences rélatives à la détermination du kilogramme ont été effectuées à zéro ou à quelques dixièmes de degré au-dessus; rien n'etait done plus facile que de s'en tenir à ces premiers résultats. Il est également certain que les savants français avaient admis, en formulant leur programme, que l'unité de poids serait le décimètre cube d'eau liquide à zero. C'est une acte de déference envers M. Trallés, délégué de la Suisse, qui a fait accepter, par les commissaires français, le maximum de densité de l'eau comme terme fixe.

Faut-il le regretter? Nous ne l'examinons pas. Le kilogramme des archives est une unité tellement conforme à sa definition qu'il serait impossible de la modifier d'une manière appréciable pour les besoins ordinaires de la société.

Y-a-t-il lieu de faire pour les savants un kilogramme qui soit capable de satisfaire aux exigences des expériences ultérieures, par lesquelles le maximum de densité de l'eau serait fixé d'une manière définitive? Nous ne le pensons pas. Il paraîtrait bien plus naturel de garder, pour les besoins de la science, le kilogramme tel qu'il est, et de modifier en un point secondaire sa définition, ce qui serait sans conséquence.

La Commission ne saurait donc accepter, ni pour la détermination du mètre, ni pour celle du kilogramme, qu'il y ait lieu d'admettre l'utilité de nouvelles opérations ayant pour objet de fixer les deux types de ces mesures. Si, sous prétexte du progrès de la science, on acceptait que ces types peuvent être modifiés aujourd'hui, leur instabilité se perpétuerait d'âge en âge; les savants de chaque siècle pourraient, en effet, avoir la prétention d'introduire à leur tour de nouvelles corrections dans les méthodes employées par leurs prédécesseurs.

La Commission, après avoir décidé à l'unanimité, qu'il y a lieu de considérer les prototypes du mètre et du kilogramme déposés aux archives comme invariables et comme appartenant à toutes les nations, a examiné ce qui restait à faire pour permettre aux délégués de tous les pays d'intervenir dans l'étude des moyens à employer pour en reproduire des copies authentiques destinées à servir d'étalons. Il lui a paru que, pour conserver au système métrique son large caractère d'universalité et pour dégager de plus en plus la France de toute prétention à une prépondérance qu'elle n'a jamais déclarée, il convenait de continuer ce qui s'était fait dès l'origine de ce travail, et d'appeler à un nouveau concert les nations étrangères.

Elle a donc l'honneur de proposer à l'Académie de demander au Gouvernement de provoquer la formation d'une Commission Internationale qui serait chargée d'étudier les moyens d'exécution des étalons destinés aux divers pays, et de choisir les méthodes de comparaison ou les instruments de vérification qu'il convient de mettre en usage pour les obtenir dans l'état actuel de la science.

4.—Report to the Emperor by the French Minister of Commerce, and appointment of the French Members of the Metric Commission.

(From the "Journal Officiel de l'Empire Français.")

Jeudi, 2 *Septembre* 1869.

Partie Officielle.

RAPPORT À S. M. L'EMPEREUR.

Sire, Paris, le 1er Septembre.

Le ministère de l'agriculture et du commerce, lors de sa création, a reçu du ministère de l'intérieur, parmi ses attributions les plus utiles, celle d'assurer, de propager et de surveiller, dans toute l'étendue du territoire l'usage général et uniforme des mesures métriques, et l'organisation de service du vérification a successivement reçu, par ses soins, des améliorations importantes.

Mais c'est principalement depuis la promulgation de la loi de 1837, qui a rendu l'emploi de ces mesures obligatoire, que ce service a commencé à fonctionner d'une manière régulière.

Des bureaux de vérification ont été organisés dans tous les chefs-lieux de département et d'arrondissement; ces bureaux ont été pourvus d'étalons vérifiés, et de nécessaires perfectionnés, à l'usage des vérificateurs; pour assurer la conservation de ces étalons, cette loi avait prescrit qu'une vérification générale en serait faite tous les dix ans.

Cette prescription, que les événements avaient empêché d'observer vers 1848, à laquelle le Gouvernement de l'Empereur avait voulu satisfaire dès 1852, n'a pu s'accomplir par les soins de mon département, faute des crédits nécessaires, qu'en 1867. Elle est terminée aujourd'hui, et les 371 bureaux de vérification sont actuellement pourvus d'étalons du mètre, du kilogramme et du litre, d'une précision réglée par une tolérance de 1/100,000^{e} au plus de la valeur rigoureuse, ce qui dépasse tous les besoins du service intérieur.

A la même époque de 1837, le Gouvernement français s'etait également préoccupé des relations à établir avec les pays étrangers pour parvenir à propager l'usage du système métrique, de mesures dont les avantages commençaient à y être de plus en plus appréciés par les hommes de science et par les ingénieurs.

Des dispositions furent prises, en conséquence, pour faciliter et multiplier les échanges et les comparaisons de mesures entre les divers Etats. En 1840, le ministère de l'agriculture et du commerce avait commandé aux ateliers de l'illustre Gambey, membre de l'Académie des Sciences, la construction de collections de mesures métriques destinées à ces échanges, que le ministère des affaires étrangères fut invité à provoquer par l'intermédiaire des agents diplomatiques.

Le service de ces comparaisons et de ces échanges fut confié en 1848 au Conservatoire des Arts et Métiers; tous les étalons primitifs que possédait le ministère de l'agriculture et du commerce furent remis à cet établissement, ainsi que les instruments et les appareils de vérification.

Depuis cette époque, ce service n'a pas cessé de fonctionner et de s'améliorer. Des instruments nouveaux et plus précis ont été ajoutés aux anciens; des procédes ingénieux ont été imaginés pour opérer toutes les vérifications demandées, avec l'exactitude qu'exigent aujourd'hui la science et les arts de précision.

En même temps que ces efforts persévérants amélioraient et perfectionnaient le service des poids et mesures métriques en France, les avantages de ce système, si logique et si simple, étaient de plus en plus appréciés à l'étranger.

L'opinion des savants les plus distingués se prononçait partout en faveur de sa genéralisation; les échanges se multipliaient, et le nombre des Etats qui l'adoptaient croissait graduellement. Non-seulement les gouvernements étrangers répondaient avec empressement à nos propositions d'échange de mesures, mais, attachant avec raison le plus grand prix à la précision des comparaisons à faire, ils déléguaient les savants et les physiciens les plus distingués pour participer à ces opérations, dont tous les résultats étaient ainsi vérifiés et contrôlés par les délégués intéressés.

L'empressement avec lequel toutes les demandes de ce genre ont été accueillies par le Gouvernement de Votre Majesté, l'accord qui n'a jamais cessé de régner, pour toutes ces opérations délicates, entre les savants étrangers et français, ont porté leurs fruits; les échanges se sont multipliés et la tendance à l'adoption universelle de notre système s'est manifestée d'une manière plus prononcée.

Aujourd'hui douze Etats étrangers l'ont introduit et prescrit officiellement: ce sont la Belgique, les Pays-Bas, l'Italie, les Etats pontificaux, l'Espagne, le Portugal, la Grèce, le Mexique, le Chili, le Brésil, la Nouvelle-Grenade, les républiques de l'Amérique méridionale.

Malgré son désir de satisfaire à toutes les demandes semblables et de les voir se multiplier, le ministre de l'agriculture et du commerce devait se préoccuper de la necessité d'aviser aux moyens d'assurer aux étalons des archives une parfaite conservation. Une commission, désignée par l'un de mes prédécesseurs, a pu établir dans des conditions exceptionnellement favorables la comparaison entre eux et ceux du Conservatoire, qui devaient exclusivement être employées aux vérifications exigées par le développement du système métrique à l'étranger.

Dix-huit autres Etats ont reçu des étalons secondaires, vérifiés par les soins du départment de l'agriculture et du commerce.

Appendix XIII.—*continued.*

Mais là ne doit pas s'arrêter ce mouvement de généralisation d'un système uniforme de poids et de mesures qui, n'ayant en apparence pour but que des objets matériels, est appelé peut-être à exercer sur les nations éclairées une influence pacifique et civilisatrice plus grande qu'on ne serait tenté de le penser au premier aperçu.

Les Expositions universelles de 1851, 1855, 1862, 1867, en rapprochant, en mettant en rapport les savants, les ingénieurs, les industriels, les commerçants de toutes les nations, ont mis de plus en plus en évidence les avantages d'un système d'unités communes qui serviraient de bases à tous les travaux, à tous les calculs, à toutes les transactions, qui constitueraient en quelque sorte un langage universel.

Déjà dans une grande partie de l'Europe, sans prescriptions administratives, sans mesures légales et par la seule force des choses, la plupart des savants et des ingénieurs ont adopté pour leurs calculs, pour leurs travaux, pour l'enseignement, l'usage des mesures métriques. Là où il n'est pas prescrit par la loi, il est souvent, comme en Angleterre, autorisé par elle; partout il est admis ou toléré.

Des commissions scientifiques, internationales ou libres, se sont prononcées à diverses reprises sur cette importante question, et toutes, sous des formes et parfois avec des restrictions différentes, ont admis en principe l'utilité générale et l'opportunité de l'adoption d'un système décimal des mesures conforme à celui de la France, et basé sur des étalons métriques déposés dans nos archives.

Tout récemment, cette question a pris un caractère d'une urgence plus pressante encore, par suite de l'initiative des sociétés savantes de l'Allemagne, et d'une commission d'enquête constituée en Angleterre pour l'examen des étalons officiels.

La Conférence géodésique internationale pour la mesure des degrés en Europe, qui avait principalement en vue les opérations géodésiques en cours d'exécution, et en projet pour l'ensemble des Etats allemands, dans ses séances de 1867, a émis les vœux suivants:

" 4°. Il est dans l'intérêt des sciences en général, et de la géodésie en particulier, qu'un système unique de poids et mesures, avec subdivisions décimales, soit adopté en Europe.

" 7°. Afin de définir l'unité commune des mesures pour tous les pays de l'Europe et pour tous les temps, aussi exactement et aussi invariablement que possible, la commission recommande la construction d'un nouveau mètre prototype Européen. La longueur de ce mètre Européen devrait différer aussi peu que possible du mètre des Archives de Paris, et doit en tout cas lui être comparée avec la plus grande exactitude.

" 8°. La construction du nouveau prototype, ainsi que la confection et la comparaison de ses copies destinées aux différents pays, devraient être confiées à une commission internationale dans laquelle les Etats intéressés seraient représentés."

L'Académie de Saint-Pétersbourg, saisie de la même question, a décidé:

" 1°. Que l'Académie emploie son autorité pour solliciter S. Exc. M. le ministre de l'instruction publique d'intervenir auprès du Gouvernement impérial pour que tous les Etats étrangers soient invités à envoyer des délégués pour former une commission internationale qui devra se réunir dans une des capitales, encore à désigner, dans le but de régler la confection des étalons, prototypes métriques, et de créer une unité de mesure véritablement universelle et effectivement internationale."

La Commission Anglaise des étalons (1869), dans son second rapport, conclut ainsi qu'il suit:

" 1°. Considérant les résultats des renseignements recueillis par la commission: sur le grand développement des relations internationales, spécialement en ce qui concerne l'industrie et le commerce;

" Sur l'adoption générale du système métrique des poids et mesures dans plusieurs Etats, soit de l'Europe, soit des autres parties du monde, et plus récemment dans la Confédération de l'Allemagne du Nord, et dans les Etats-Unis d'Amérique;

" Sur les progrès de l'opinion publique de ce pays, en faveur du système métrique, comme système international uniforme de poids et mesures, et sur la généralisation de l'emploi de ce système dans les recherches scientifiques et la pratique des travaux de chimie et de génie civil;

" La commission est d'avis qu'il y a lieu, pour le gouvernement, de régler par des dispositions législatives et de faciliter l'introduction et l'usage des poids et mesures métriques dans le Royaume-Uni.

" Que dans ce but, des étalons métriques, comparés avec soin avec les étalons primitifs de Paris, et déposés parmi les étalons officiels du département du commerce, soient légalisés, et que des copies vérifiées de ces étalons métriques puissent être mis à la disposition des autorités locales pour les inspecteurs des districts qui en exprimeront le désir.

" 2°. La commission pense que la nomenclature française doit être introduite en ce pays, aussi bien que les divisions décimales du système métrique."

Le gouvernement de l'Inde Anglaise, dans un rapport longuement motivé, et basé sur les difficultés sans nombre que crée au commerce la multiplicité infinie des mesures en usage dans les diverses parties de ce vaste empire, proposait déjà en 1867 de "s'adresser, par l'intermédiaire des autorités compétentes, au bureau du ministère de l'intérieur, à Paris, à l'effet d'obtenir une série complète de mesures métriques vérifiées avec soin.

" 7°. Le système métrique doit être enseigné dans toutes les écoles du gouvernement, et sa connaissance doit être exigée dans tous les examens de l'Université et de tous les candidats aux fonctions publiques."

Toutes ces conclusions concourent donc à proclamer:

1°. Les avantages du système métrique français.

2°. La convenance pour les pays étrangers d'en adopter ou d'en autoriser l'usage.

3°. La nécessité, pour eux, de se procurer des étalons secondaires qui après avoir été comparés avec toute la précision que comporte et qu'exige la science actuelle, puissent servir, en chaque pays, pour généraliser l'usage du système.

Ce concert d'opinions émanées de tant de savants et d'hommes distingués de tous les pays éclairés, cet hommage universel et spontané rendu à la grande pensée qui avait présidé dès 1790 à la création du système uniforme de nos poids et mesures, et qui justifie les espérances dont nous aurions pu croire la réalisation réservée à nos arrière-neveux, ne pouvait manquer de frapper l'attention du Gouvernement de Votre Majesté, et de celle de tous les amis de la science et des gloires françaises.

L'Académie des Sciences, le Bureau des Longitudes, vos ministres s'en sont émus, et une commission a été constituée en 1868, sous la présidence de M. le maréchal Vaillant, pour aviser aux moyens de donner satisfaction aux désirs des gouvernements étrangers, en conservant à la France la part d'action et d'initative qui lui appartient.

Cette commission a formulé dans ce but les conclusions suivantes, dont je propose à Votre Majesté d'approuver le sens général:

1°. Décider. . . . . qu'il sera fait une copie légale, par un mètre à traits, du mètre à bouts des Archives.

2°. Décider que cette copie sera effectuée par une commission française à laquelle seront appelés des commissaires désignés par les puissances étrangères.

3°. Nommer, par un décret, une commission chargée dès à présent de préparer les éléments du travail.

Lors de la création de la grande commission scientifique chargée de l'immense travail que ses membres, parfois au péril de leur vie, et au milieu des orages du temps, ont accompli avec tant de dévouement et d'abnégation, la Convention nationale avait appelé à s'associer à tous leurs travaux des délégués des nations étrangères alors en relations avec la France.

Aujourd'hui plus que jamais, en présence de cette paix générale dont la continuation est le vœu le plus cher de Votre Majesté, il convient de provoquer de la part de toutes les puissances qui désireraient y participer la coopération de savants chargés de prendre part à toutes les études et à toutes les résolutions propres à donner une confiance entière dans l'exactitude des étalons secondaires, dérivés de nos étalons métriques des Archives, qui doivent rester les types uniques et invariables de tous les autres.

D'une autre part, de pareils travaux exigent des études, des dispositions préparatoires pour éviter des pertes de temps et pour permettre d'attendre le plus promptement possible le but désiré. Les moyens d'exécution que possède déjà le Conservatoire impérial des arts et métiers, où je me propose de concentrer les opérations, me permettent de croire que cet important travail pourra se faire avec toute l'exactitude et toute la rapidité désirables.

En conséquence, j'ai l'honneur de proposer à Votre Majesté de constituer dès à présent la commission qui doit représenter la France dans le travail collectif, et qui se composerait de:

MM.

Mathieu, membre de l'Institut, président;

Général Morin, membre de l'Institut, directeur du Conservatoire impérial des arts et métiers, vice-président;

Le Verrier, membre de l'Institut, directeur de l'Observatoire impériale;

Laugier, membre de l'Institut et du Bureau des longitudes;

Faye, membre de l'Institut et du Bureau des longitudes
Fizeau, membre de l'Institut;
H. Sainte-Claire Deville, membre de l'Institut;
Général Jarras, directeur du dépôt de la guerre;
Tresca, sous-directeur du Conservatoire impérial des arts et métiers, secrétaire.

2°. D'inviter les gouvernements étrangers qui désireraient se procurer des étalons métriques, comparés à ceux des Archives, à déléguer des savants qui seraient appelés a prendre part aux travaux de la commission.

3°. D'ordonner que l'étalon prototype du mètre en platine des Archives sera communiqué à la commission, sous la surveillance et avec le controle de M. le directeur général des Archives de l'Empire, pour servir à la comparaison définitive du mètre à traits qu'il s'agit d'établir, et qui restera à la disposition de mon ministère, pour servir, avec les autres prototypes, aux vérifications internationales.

Je suis, avee le plus profond respect,
Sire,
De Votre Majesté,
Le très-humble et très-obéissant serviteur et fidèle sujet,
Le ministre de l'agriculture et du commerce,
ALFRED LE ROUX.

Approuvé:
NAPOLÉON.

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5. LETTER from M. DE JACOBI to M. DUMAS, Secretary to the French Academy of Sciences.

LETTRE *adressée à* MONSIEUR DUMAS, *Sénateur, Membre de l'Institut de France, par* MONSIEUR DE JACOBI, *Conseiller privé, Membre de l'Académie des Sciences de St. Pétersbourg.*

Oxford, 12e Septembre 1869.

MONSIEUR ET ILLUSTRE CONFRÈRE,

UNE excursion entreprise pour visiter quelques districts manufacturiers d'Angleterre me l'a rendu impossible de répondre plus-tôt à votre lettre du 5e, et de vous exprimer la satisfaction que m'a fait éprouver son contenu. Les légères craintes que j'ai eues concernant l'interprétation que ma proposition pourrait rencontrer en France, sont heureusement dissipées, et je vous remercie cordialement de la part que vous avez eue, je n'en doute pas, à l'obtention de ce résultat,

Il ne sera pas mal-à-propos, je crois, de vous donner quelques explications sur l'origine de ma proposition, qui n'a été faite que dans l'intérêt de l'adoption la plus générale et la plus complète du système métrique français.

Le mètre imposé au monde comme mesure naturelle a trouvé, vous le savez, des objections sur la gravité desquelles je ne veux pas me prononcer. Fondées ou non-fondés, ces objections, malgré leur fréquente réfutation et les protestations énergetiques dont elles ont été l'objet, ont cependant eu pour effet de produire, et de justifier en apparence, les hésitations des gouvernements, les susceptibilités des nations, les inquiétudes des savans. Ma proposition adoptée par le monde savant, et appuyée par les raisons pratiques d'opportunité comme on les fait valoir en faveur du système métrique, fera disparaître du même coup, j'espère, les entraves que je viens de signaler.

Je n'ai pas sous-mains les matériaux nécessaires pour écrire une dissertation, mais permettez-moi, Monsieur et illustre confrère, d'expliquer mon idée en peu de mots:

Je me suis demandé: qu'est ce que serait arrivé, si à la création du système métrique on avait construit, *exactement avec les mémes soins et rigoureseument dans les mémes conditions*, un certain nombre d'étalons métriques basés sur le pied-royal de France, ou la toise de Pérou, et sur les résultats de la mesure de l'arc méridien? Il n'y a pas de doute que la méthode employée tous les jours dans les sciences aurait suffi pour y donner la réponse. En effet on aurait établi un calcul de probabilité pour trouver la valeur d'un étalon dont les étalons confectionnés comme nous l'avons dit, aussi uniformément que possible se seraient écartés le moins possible; enfin on aurait déclaré que le résultat de ce calcul, c'était la véritable unité. Ces étalons auraient eu tous le caractère d'originaux, et aucun d'eux n'aurait joui de quelque préférence à l'égard de l'autre. Pour conférer à un quelconque d'entre eux l'honneur d'être gardé aux Archives, il n'y aurait pas eu d'autre moyen que le tirage au lot. On n'aurait pas eu même le droit d'accorder l'honneur en question à tel étalon qui aurait présenté le moins d'écart du mètre idéal. L'objection que ce mètre idéal aurait été variable, et pour ainsi dire une fonction du nombre d'étalons confectionnés, n'est d'aucune importance, en considération de la petitesse des erreurs d'observation, de l'égalité de leur poids, et des signes contraires dont elles auraient été affectées.

J'ai supprimé ces considérations dans mon rapport pour éviter l'apparence de vouloir empiéter sur les travaux de la Commission Internationale future, mais vous me permettrez d'ajouter encore quelques mots à ce sujet.

Comme jadis pour fonder le mètre on avait pris le pied de France pour unité de mesure, l'on se servira aujourd'hui pour fonder le nouveau mètre (idéal), du mètre des Archives de France, ou si celui-ci n'est pas accessible, d'une quelconque de ses copies. Il est facile à voir qu'en y appliquant le même raisonnement et les méthodes mentionnées, on ne fera que revenir au point de départ. En effet le mètre idéal qu'il s'agit de créer, s'écartera *d'autant moins du mètre des Archives, ou de son substitut, que le nombre d'étalons confectionnés rigoureusement dans les mémes conditions, et avec les mémes soins extrémes, sera plus considérable.*

En resumé, les résultats obtenus par cette manière de procéder seront:

1°. Le mètre idéal n'aura pas de réprésentation matérielle il ne différera du mètre de Archives, ou de son substitut, que d'une quantité assez insignifiante pour échapper entièrement aux moyens d'observation dont nous disposons aujourd'hui, ou dont nous disposerons dans un avenir prochain.

2°. Les étalons construits sous les auspices de la Commission internationale seront tous des originaux dont aucun ne jouira d'une préférence à l'égard de l'autre.

3°. Le mètre des Archives sera devenu la véritable unité universelle qui n'appartiendra à aucune nation en particulier et sera ainsi élevé au-dessus de toute susceptibilité nationale.

Enfin, d'une manière ou de l'autre, j'émets le vœu fervent que l'Académie des Sciences de Paris accepte la mission de couronner le grand œuvre initié par les travaux à jamais mémorables de ses plus illustres prédécesseurs.

Agréez, Monsieur et illustre confrère, l'assurance de ma plus haute considération et de mon dévouement le plus sincère.

M. H. DE JACOBI.

À. M. Dumas, Sénateur,
Membre de l'Institut.

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6. — PAPER read before the FRENCH ACADEMY by M. DE JACOBI, on 19th October 1869.

SUR la confection de l'unité prototype du système métrique, lu par M. Jacobi dans la dernière séance de l'Académie des Sciences.

(From the "JOURNAL OFFICIEL DE L'EMPIRE FRANÇAIS, 20th October 1869.")

M. le secrétaire perpétuel a bien voulu m'engager à profiter de mon court séjour à Paris pour donner à l'Académie quelques explications concernant la proposition faite par l'Académie des Sciences de Saint-Pétersbourg de former une commission internationale dans le but de régler la confection des étalons prototypes et de créer une unité de mesure véritablement universelle et effectivement internationale.

L'Académie des Sciences de Saint-Pétersbourg n'a jamais laissé échappé l'occasion de se prononcer en faveur du système métrique francais. Autant que c'était dans ses attributions, elle n'a cessé de recommander à l'administration l'adoption de ce système; mais c'est surtout au point de vue de la science qu'il lui a paru indispensable que les savants de tous les pays adoptassent un langage uniforme en tout ce qui concerne l'expression des quantités mesurables. Pour rendre ses convictions à cet égard plus manifestes, elle a d'abord formellement émis le vœu que ses membres se servent à l'avenir, dans leurs publications, uniquement des poids et mesures du système métrique français. Ensuite elle a décidé que des invitations soient adressées aux universités et aux autres corporations scientifiques et techniques du pays, d'adopter le même moyen et de soumettre à M. le ministre de l'instruction publique un mémoire pour attirer son attention sur les avantages de répandre dans les écoles primaires une connaissance plus étendue du calcul décimal et de ses applications au système métrique. Enfin, dès l'année prochaine, les observations météorologiques faites dans les nombreux établissements répandus sur le vaste territoire de la Russie seront publiées en mesures métriques, et quant aux thermomètres en centigrades.

Il est vrai que ces décisions ne concernent que des applications du système métrique dans les sciences, mais l'Académie est convaincue que la force des choses ne tardera pas à étendre ces applications sur d'autres domaines encore. Aussi est-il constaté par mille exemples que les vérités et les faits acquis par la science sont des germes indestructibles qui font éclosion là où l'on s'y attend le moins. Ce n'est donc qu'une question de temps de voir subir aux admi-

Appendix XIII.—*continued.*

nistrations aujourd'hui les plus réfrctaaires, l'influence irrésistible de ces faits et de ces vérités.

Pour désigner nettement la position de l'Académie des Sciences de Saint-Pétersbourg vis-à-vis du système métrique français, il suffit de renvoyer à la proposition mentionnée, dans laquelle elle a déclaré qu'elle reconnait à ce système tous les avantages d'un système universel des poids et mesures, et qu'elle considère les étalons déposés aux Archives de France comme les étalons prototypes de ces mesures. Quant à l'origine de ces prototypes, elle en a toujours tenu compte pour s'inspirer du glorieux exemple de vos illustres prédécesseurs, qui n'ont pas reculé devant les immenses difficultés qui s'opposaient à l'accomplissement de leur mission. Elle a tenu aussi compte de la critique de leurs travaux. La mesure de l'arc méridien français, en la confrontant avec les remarquables travaux exécutés depuis, n'est pour elle qu'une confirmation de plus que malgré toutes les hypothèses et tous les calculs, la nature n'a pas pu faire de la figure de la terre un ellipsoïde de révolution.

Le monde savant, en adoptant pour les besoins de la science un prototype quelconque comme mesure universelle, et qui doit servir non-seulement au présent, mais également à un avenir éloigné, fait un acte d'une haute importance. Il ne peut le faire sans s'imposer des devoirs graves, pour l'accomplissement desquels il est responsable envers la postérité. Sous ce rapport, il doit être inexorable et surtout ne pas faire des concessions qui pourraient le faire déroger de ses convictions ou forfaire à sa conscience scientifique. Il croit de son premier devoir de se préoccuper et de s'inquiéter de l'intégrité de son prototype et de sa conservation illimitée, autant qu'il est permis à l'homme de se servir de cette expression, et il ne peut remplir ce devoir qu'en rendant le monde civilsé entier responsable de cette intégrité et de cette conservation. Ceci s'applique à un prototype de convenance quelconque que le monde savant aurait été libre de choisir, en faveur duquel on aurait pu faire valoir des raisons d'opportunité plus ou moins fortes, et auquel il n'aurait pas été impossible d'appliquer l'organisation parfaite et logique du système métrique français. En renonçant, je suppose, à tout jamais à toute alternative à cet égard, et en adoptant franchement comme son protoype unique l'étalon déposé aux Archives de France, le monde savant cède moins à une nécessité matérielle qu'au besoin de rendre un hommage éclatant qui est en même temps un juste tribut de reconnaissance non-seulement à la glorieuse initiative de la France et de ses illustres savants, mais pas moins aux sacrifices matériels et intellectuels qu'elle n'a pass cessé de porter pendant plus d'un demi-siècle au développement de cette œuvre importante.

A l'état où nous en sommes, le problème de rendre le monde civilisé entier responsable de l'intégrité et de la conservation illimitée de son étalon prototype, n'est plus le prototype exclusif de la France, mais celci du monde entier, ce problème n'admet qu'une seule solution correcte. Il ne suffit point, à cet effet, de faire une copie à trait de l'étalon à bout des Archives, non plus que d'envoyer un délégué d'un pays quelconque à Paris pour prendre de cette copie à trait une nouvelle copie, et d'employer à cet effet un métal quelconque qui lui semble le plus propre; en un mot, il ne s'agit plus d'entreprendre des travaux isolés, quelque méritoires qu'ils soient, mais d'un travail collectif auquel participeront au même titre et sur le pied d'égalité, les délégués de tous les pays. Ce travail collectif consistera à faire fabriquer à la fois, et dans les meilleures conditions possibles, un nombre considérable d'étalons prototypes sur le modèle de l'étalon des Archives françaises; d'employer à cette fabrication des substances qui, par leur composition chimique, par leur constitution moléculaire, par leur coëfficient de dilatation par la chaleur, présenteront toutes les garanties d'homogénéité que les progrès de la technique et des arts métallurgiques peuvent offrir. Ces copies, auxquelles on donnera exactement les mêmes dimensions, seront comparées avec l'étalon prototype, et entre elles, au moyen d'un comparateur qui réunira tout ce que la science, de concert avec la technique et la mécanique des instruments de précision, pourra produire de plus accompli, et dont la construction ne sera gênée par aucune considération d'économie. Les étalons, ainsi construits et rendus identiques par leur longueur dans les limites les plus restreintes, seront distribués aux différents pays, où ils seront conservés dans des conditions similaires, qui les mettront autant que possible à l'abri de toute atteinte extérieure et des influences élémentaires.

L'avantage de cette opération, dirigée avec des soins extrêmes et sous les auspices des personnes les plus compétentes, sera d'établir ce système métrique international sur les bases les plus larges, et de lui assurer toute la solidité requise. En effet, en considération de la perfection extrême des moyens de confection et des méthodes de comparaison employées, les étalons sortis de cette opération collective ne seront pas des copies dans l'acception usuelle de ce mot, mais des véritables étalons prototypes dont chacun aura le droit, je ne dis pas *historique*, mais *scientifique*, de remplacer l'original dans les Archives de France. Ceci est d'autant plus vrai, qu'il nous est permis de supposer que les moyens de confection et de vérification que nous emploierons ne seront pas inférieurs à ceux employés il y a soixante-dix ans. Et si l'on s'avisait de construire à côté de nos copies exactes du mètre des Archives un même nombre d'étalons dont chacun serait tenu d'avoir une longueur de 3 pieds 11 lignes 296 millièmes du pied royal de France, nous obtiendrions à coup sûr les mêmes résultats, c'est-à-dire deux séries de mesures équivalentes sous tous les rapports. Ou, en d'autres mots, nous espérons que les étalons de la commission internationale future exprimeront la longueur de 3 pieds 11 lignes 296 millièmes avec la même exactitude que cette mesure de longueur est représentée par l'étalon prototype des Archives de France.

Le but de la commission internationale sera atteint dès qu'il n'y aura aucun centre de civilisation qui ne possédera pas le mètre des Archives dans un ou plusieurs de ses équivalentes, et qu'ainsi toutes les garanties exigibles concernant la perpétuité du système dont il forme la base ne soient acquises.

7.—REPORTS of the STANDARDS COMMISSION of the NORTH GERMAN CONFEDERATION upon the proposal of an International Conference to be convoked at Paris on the Subject of a Primary Standard Measure.

(Translated from the German, by the Warden of the Standards.)

Berlin, 29th December 1869.

To his Excellency the President of the Federal Chancery Department, the Royal Prussian Minister of State and Privy Councillor, Herr Delbrück, Knt.

In pursuance of directions to that effect, dated 20th December 1869, the undersigned Commission has the honour to report as follows:—

The proposal of the Imperial Government, conveyed in the letter from the French Embassy at Berlin of 24th November last, for calling together an International Conference, to whom should be entrusted the construction of a mètre à traits, and its comparison with the mètre à bouts deposited at the Imperial Archives, is hailed with satisfaction by the Standards Commission of the North German Confederation, as the first preliminary step in proceedings which have now become indispensable.

The Commission has already, on 30th September last, in a paper to your Excellency, a copy of which is appended, expressed to your Excellency its opinion upon a suggestion of the Imperial Academy at St. Petersburg, and has stated the necessity of a new and international discussion of all questions relating to a Primary Standard, and generally of all other more profound metronomical problems.

The members of the Standards Commission as representing men of science in North Germany are therefore certainly ready to take part in the proposed International Conference at Paris for the regulation of this important subject; the more so, as gratitude due to French genius, for the first conception and carrying out of the fruitful groundwork of the metric system, would in a high degree justify a reunion in Paris of the representatives of those states who are now interested in this system.

On the other hand, the Commission must declare most emphatically that they do not consider it would be advisable to send delegates to such an International Conference at Paris, if its duties were limited solely to the construction of a mètre à traits and its comparison with the mètre à bouts of the Imperial Archives.

The Commission could not accede to such a limitation of the subjects of international discussion, for this reason amongst others, that any further admission of the mètre des Archives, in its existing condition, as a universal standard of measure, is exposed to the gravest doubts, of which the exhaustive discussion should be in no way excluded. The Commission is of opinion that the French nation would be in danger of losing the pre-eminent position which it has gained in this department of science by the establishment of the metric system, if it insisted on maintaining any further what has till now been the prototype of this system, without allowing the fullest discussion, and did not also yield unconditional respect to the clearly pronounced decisions of strict science upon this point.

It would consequently be desirable that the Imperial French Government should enlarge the programme of international discussion, proposed in their invitation, either in the sense above expressed, or, what may be still better, that they should leave to such a Commission itself to determine the programme of their discussions.

THE STANDARDS COMMISSION OF THE
NORTH GERMAN CONFEDERATION.

(*Enclosure.*)

COPY OF RESOLUTION OF THE STANDARDS COMMISSION OF THE NORTH GERMAN CONFEDERATION, dated 30th September 1869, on the Report of the Commission of the Imperial Academy at St. Petersburg, of June 1869, on the subject of International Standards of Metric Measure and Weight.

As it is of great importance not only for that degree of uniformity, precision, and solidity of a primary standard of measure and weight, required in consequence of the risk of multiplying and increasing errors in copies used for trade purposes, but also for many scientific investigations, that such measures and weights as are constructed with the greatest precision attainable at the time, should be maintained invariable as far as possible, and that every facility should at the same time be afforded for their remaining at all times accessible for accurate and convenient comparisons,—as further, the not sufficiently perfect condition, and not sufficiently accurate manipulation of the existing prototypes of the metric system have given rise to serious evils, and occasioned obstacles to the general adoption of the metric system,—it has consequently been declared by the Standards Commission of the North German Confederation, at their full meeting, on 6th September 1869, that it is indispensably requisite for the above specified interests of all those countries which have adopted the metric system, or contemplate its adoption, that they should unite in new consultations and proceedings, with the view to the establishment and maintenance of a common and universal standard of measure and of weight.

The Standards Commission of the North German Confederation therefore declares that it is prepared, in accordance with the views expressed by the Imperial Academy at St. Petersburg, to take part in a thorough international treatment of this subject.

THE STANDARDS COMMISSION OF THE
NORTH GERMAN CONFEDERATION.

Berlin, 30th September 1869.

A true translation.
H. W. CHISHOLM,
Warden.

Standards Department,
7th February 1870.

8.—COPY OF LETTER from the FRENCH AMBASSADOR at London, to the EARL OF CLARENDON, Foreign Secretary of State, containing an invitation from the Imperial Government of France, to send scientific men as representatives of the United Kingdom to take part in an International Commission appointed by the Emperor to meet at Paris, for the purpose of the construction and verification of legal International Standards of weight and measure, based upon the primary Metric Standards, the mètre des Archives, and the kilogramme des Archives, and thus to facilitate the solution of the question of a Universal International System of Weights and Measures.

(Forwarded by the Foreign Office to the Treasury, with the request of their opinion as to the answer to be returned, and by the Treasury to the Board of Trade, asking for any remarks they may have to make on the proposition. Referred by the Board of Trade to the Warden of the Standards for remarks.)

From the MARQUIS DE LA VALLETTE, FRENCH AMBASSADOR AT LONDON, to the EARL OF CLARENDON, HER MAJESTY'S FOREIGN SECRETARY OF STATE.

Ambassade de France, en Angleterre,
Londres, le 19 Novembre, 1869.

MONSIEUR LE COMTE,

L'EMPEREUR, désirant associer son Gouvernement aux efforts universellement tentés par la science pour répandre l'usage des mesures métriques, a décidé sur la proposition de M. le Ministre de l'Agriculture et du Commerce, et conformément au vœu de l'Académie des Sciences:

1°. Que par les soins d'une Commission spéciale, il serait fait une copie légale, par un mètre à traits, du mètre à bouts déposé aux Archives de l'Empire.

2°. Que les Gouvernements étrangers seraient invités à déléguer des savants chargés de prendre part à toutes les études et à toutes les résolutions propres à donner une confiance entière dans l'exactitude des étalons secondaires dérivés de ceux des Archives.

La participation sur un pied d'égalité complète des savants étrangers et français a paru au Gouvernement de l'Empereur le moyen le plus sûr de conserver au système métrique son caractère d'universalité, et d'obtenir des types véritablement internationaux, parfaitement comparés à ceux des Archives de l'Empire, susceptibles de servir dans chaque pays, à tous les travaux scientifiques, en même temps que de préparer l'adoption générale du système.

En me priant, M. le Comte, de porter à votre connaissance les mesures que le Gouvernement de l'Empereur considère comme les plus propres à faciliter une solution commune et internationale de cette question, S. E. M. le Ministre des Affaires Etrangères exprime l'espoir que le Cabinet de Londres, appréciant le caractère éminemment utile de l'œuvre qu'il s'agit d'accomplir, accueillera favorablement la proposition de se faire représenter au sein de la Conférence générale.

Je serai particulièrement reconnaissant à votre Excellence de vouloir bien me faire connaître la decision que sera prise à ce sujet par le Gouvernement de la Reine, et de me désigner, s'il y a lieu, les noms des savans anglais auxquels sera confiée la mission de prendre part à des travaux si dignes de l'intérêt de toutes les nations civilisées.

Veuillez agréer, &c.
(Signed) LAVALLETTE.

9.—See further, Ss. 3 and 4 of Minutes of Proceedings of the Standards Commission on 21st December 1869, with reference to this letter from the French Ambassador; and their opinion that three members to the Scientific Conference at Paris should be nominated on the part of this country, viz., the Astronomer Royal, Professor W. H. Miller, and the Warden of the Standards. On this recommendation being reported to the Board of Trade, it was forwarded with their concurrence to the Treasury.

See also S. 10 of Minutes of Proceedings on 2nd April 1870.

10.—SECRETARY of TREASURY to SECRETARY of BOARD of TRADE, with enclosure.

Treasury Chambers,
May 7, 1870.

SIR,

I AM directed by the Lords Commissioners of Her Majesty's Treasury to transmit to you herewith, to be laid before the Lords of the Committee of Privy Council for Trade, with reference to Sir L. Mallet's letter of 10th February last, copy of a letter from this department to the Foreign Office, communicating my Lords' consent to the appointment of two delegates from England to attend the international conference on the metric system about to be assembled by the French government.

I am, &c.
JAMES STANSFELD.

T. H. Farrer, Esq.,
Board of Trade.

11.—Enclosure, SECRETARY of TREASURY to UNDER SECRETARY, FOREIGN OFFICE.

Treasury Chambers,
May 7, 1870.

SIR,

WITH reference to the letter from this department of 7th March last, relative to the International Conference to be held at Paris, on the metric system, I am directed by the Lords Commissioners of Her Majesty's Treasury to state, for the information of the Earl of Clarendon, that, after further communication with the Board of Trade on the subject, my Lords have consented to the appointment of Professor Airey, Astronomer Royal, and Professor W. H. Miller, F.R.S., as delegates from this country to the Conference, and they are prepared to sanction, as a charge on public funds, the expenses which may be incurred by these gentlemen.

Their lordships request however that, in announcing this decision to the French ambassador, Lord Clarendon will explain that the object of Her Majesty's Government is simply to facilitate the researches of the Conference and in no degree whatever to commit itself to the adoption of any conclusions at which the Conference may arrive.

I am, &c.
JAMES STANSFELD.

The Right Hon. E. Hammond,
&c., &c., &c.

(These two letters were referred by the Board of Trade on 9th May to the Warden of the Standards for statement of reasons for appointing a third delegate from this country to the Paris Conference.)

12.—MINUTES of the WARDEN of the STANDARDS, the ASTRONOMER ROYAL, and Professor W. H. MILLER, on the question of appointing the Warden of the Standards as a third delegate from this country to the Conference at Paris.

Minute of the Warden of the Standards.

As to the terms upon which the Astronomer Royal and Professor Miller have consented to act upon the Commission at Paris, I may call attention to the following extract from the minutes of the Commission:

(*From Minutes of* 21*st December* 1869, § 4.)

"The Astronomer Royal said that the pressure and variety of matters to which he was now obliged to give his attention were so great that he really feared that he could not give up time to the International Commission at Paris; but after the strong expression of opinion that he should consent to act, he could no longer refuse to be nominated and to attend at Paris during the more important deliberations of the Commission, in order to express his views upon the several subjects on behalf of this country, although it would be impossible for him to assist in any of the detailed operations. He considered that these might be well left to Professor Miller, if he could find time to give his services, and to the Warden of the Standards.

"Professor Miller said that his own duties occupied much of his attention and time, especially at particular periods of the year. During the months of February and March he must be constantly at Cambridge to deliver his lectures, and once a month his services were required at the Royal Society. He would, however, be willing to serve upon the Commission at Paris when these other duties did not intervene."

(*From Minutes of* 2*nd April* 1870, § 10.)

"It appeared upon further inquiry that Mr. Lowe objected to nominate more than two members to the Paris Commission, in which he considered that this country was not directly interested. The Warden added that he had immediately pointed out that his own appointment had also been recommended by the Commission, and that there was much detailed work requisite to be done, which it was not to be expected the Astronomer Royal or Professor Miller would undertake, whilst it was of material importance that both should be members of the Commission. The Board of Trade entirely concurred in this view, and a fresh representation had been made to the Chancellor of the Exchequer, but no reply had yet been received.

"The Astronomer Royal said that in any event he could attend at Paris only for the purpose of stating his views upon the more important points; and Professor Miller added that he could not undertake, without the assistance of Mr. Chisholm, the various detailed duties required to be performed in the observations and comparisons of standards, and reporting the proceedings."

For myself personally it would be a great relief to me not to be called upon to attend at Paris, as for some time to come, much official business will press upon me, which can be executed only by severe and incessant labour.

But the Treasury authorities do not appear to be aware of what must constitute the real business of the Conference at Paris, and that it will be strictly of a scientific and not of a political or official character, being limited to the discussion and determination, and more particularly the most efficient application, of the scientific principles upon which the construction and comparison of standards are based, including the consideration of the most appropriate materials for primary standards, and the fittest instruments of verification, and involving the necessity of numerous detailed observations with such instruments, and recording them and the requisite elaborate reductions, until a definite and satisfactory result is obtained.

Whilst for all purposes of discussion and reference on disputed points the appointment of the Astronomer Royal and Professor Miller must be most desirable, as well as amply sufficient, I can speak from my own official experience of the scientific comparison of standards, and of the protracted labour and continuous attention required, when the highest scientific accuracy is to be attained, that it is not to be expected that the Astronomer Royal and Professor Miller will undertake the execution of the duties which must devolve upon the representatives of this country at the Conference, without the assistance of the chief officer of the Standards Department.

Upon this point, however, it will be more proper that the Astronomer Royal and Professor Miller should state their own views.

But it may be allowed to me to add that in the scientific proceedings to be entered into at the Paris Conference, involving the consideration and practical application of the fundamental principles upon which the due accuracy of standard weights and measures must be based, it appears to me of much importance that the Board of Trade should be directly represented through the chief officer of the Standards department; and for these especial reasons, that by law, the executive authority over the standard weights and measures of the kingdom is vested in the Board of Trade, and that, by law, the duty of conducting comparisons, verifications, and other operations, with reference to standards of length, weight, or capacity, *in aid of scientific researches*, is imposed upon the Warden of the Standards, acting under the authority of the Board of Trade.

H. W. CHISHOLM,
Warden.

Standards Department,
10th May 1870.

MINUTE on the PROPOSED APPOINTMENT of BRITISH COMMISSIONERS to take part in the INTERNATIONAL COMMISSION to be held at PARIS for the FORMATION of NEW METRICAL STANDARDS.

By G. B. AIRY, Astronomer Royal.

As regards the active labours of the International Commission, my own part must be almost purely nominal. Under the severe pressure of the duties of my office, it is impossible that I can attend to the details of standard making, perhaps impracticable that I should go to Paris. Yet I conceive that my nomination may be important. It is well known to the foreign gentlemen who take part in the work of the Commission, that my connexion with British standards is of distant date, that my active connexion with them is of much larger duration than that of any other person living, and that some of the important movements lately made in the constitution of the Standards Office, and in the form lately given to the Standards Acts, are supposed to have been in some measure influenced by representations originated with me. Under these circumstances the omission of my name would naturally be interpreted as indicating an unwillingness on the part of British ministers and their subordinate officers to take any friendly part in the works of our continental neighbours.

In the view which I take of the policy to be adopted at home with respect to standards, my appearance as a responsible member of the International Commission may be useful. It is my deliberate opinion that our existing systems of weights and measures must be most carefully and inviolably preserved as regards home transactions; but that, with this care for affairs within our own dominions, it is also very desirable that for international purposes only, we should join in a scheme for international weights and measures. There is no prospect of any system but the Metric being adopted successfully for this purpose. In giving my aid for the acceptance by the British, as well as other nations, of the Metric system, I am establishing a claim to raise my voice in defence of the British system. In some of the French documents relating to the purposes of the proposed International Commission, the word "propagation" (of the Metric system) appeared rather conspicuous. I believe that it has been withdrawn at the instance of British officers. The word "adoption," I think remains, but it must be removed; nor will I take any part in the proceedings of the Commission, while a word of such tenor remains.

When the material labours of the Commission commence it is not impossible that I may be able to offer, by letter, some suggestions derived from my experience in the formation of the British standards. But this will in no degree interfere with the advantage, I may say, the necessity, of allowing British science to be represented by the skill and the later experience (far superior to my own) of the Warden of the Standards, who has now for many months been employed in similar works. I consider the appointment of the Warden of the Standards as one of the Commission to be indispensable.

G. B. Airy.

Royal Observatory, Greenwich,
1870, May 11th.

Minute by Professor Miller.

I have no objection to take part in the discussion of the International Conference, and a large share in making the observations required for the comparison of the proposed new metric standards; but I am not disposed to undertake the official correspondence with the authorities, either at home or in France, or the preparations of reports on the labours of the Conference.

Also, I shrink from encountering for the second time, such oppressive numerical calculations as I had to make while engaged in the restoration of the English standard of weight, and its comparison with the kilogramme of the archives.

At the period when I went through this work, I had very much more time at my own disposal than I have at present. Under the circumstances it appears to me that the presence of the Warden of the Standards as a delegate at the Conference is indispensable.

W. H. Miller.

7, Scroope Terrace, Cambridge,
1870, May 12th.

13. Treasury to Board of Trade on Appointment of Mr. Chisholm as Third Delegate to the Conference at Paris.

Treasury Chambers,
1870, May 30th.

Sir,

The Lords Commissioners of Her Majesty's Treasury have had before them Sir L. Mallet's letter of 17th instant and its inclosures, relative to the appointment of Mr. Chisholm to attend as a delegate at the International Conference on the Metric system, about to be held at Paris, in company with Professor Airy and Mr. Miller.

I am directed to state, for the information of the Lords of the Committee of the Privy Council for Trade, that, as so much importance appears to be attached to the presence of all three of the proposed delegates at the Conference, My Lords will no longer withhold their sanction to the expenses of their mission.

I have, &c.
James Stansfeld.

T. H. Farrer, Esq.,
&c. &c.

APPENDIX XIV.

Paper delivered by the Warden of the Standards.—Copies of Correspondence and Opinion of Law Officers of the Crown, on the Validity of the Official Indenture of Verification of Local Standard Weights and Measures.

Contents.

	Page
1. (30 June 1870.) From Messrs. De Grave & Co., with the following enclosures:—	
2. (29 June.) From County Auditor, Lancashire, stating objections raised against the validity of the Indenture of Verification on a charge of illegal measures - - - - -	208
3. (28 June.) From Local Inspector, county of Lancaster, stating details of objection raised -	"
4. (30 June.) Warden of the Standards to County Auditor, Lancashire, in reply - - -	209
5. (4 July.) Report of Warden of the Standards to Board of Trade, enclosing copies of preceding correspondence, and suggesting that the opinion of the Law Officers of the Crown be taken, with following enclosures:—	
6. Case for opinion of Law Officers of the Crown -	209
7. Form of Official Indenture of Verification, with certificates of Reverification endorsed - -	"
8. (7 July.) Opinion of Attorney and Solicitor General	210

1. *Messrs. De Grave & Co. to Warden of the Standards.*

59, St. Martin's le Grand, London, E.C.,
30th June 1870.

Dear Sir,

We enclose two letters received this morning from Mr. Johnston, of Preston, county auditor for Lancashire, from which you will see that a very important point has been raised as to the use of the indenture, and of such a nature as to require the opinion of the Crown advisers; under these circumstances, we should feel obliged if you would reply to Mr. Johnston direct.

Please to return us Mr. Supt. Martin's letter, and also favour us with a copy of yours to Mr. Johnston, for our information.

We are, &c.,
for self and partners,
S. R. Short.

H. W. Chisholm, Esq.,
Warden of the Standards.

2. *County Auditor, Lancaster, to Messrs. De Grave & Co.*

County Auditor's Office, Preston,
29th June 1870.

Dear Sir,

I enclose a letter from the Inspector of weights and measures in the Kirkdale district of this county, with reference to some most important cases that were brought before the county justices and adjourned until the 8th of July.

The cases in question are publicans brought up for defective measures, and I believe the Licensed Victuallers' Association have taken up the defence in consequence of the great vigilance exercised by our Inspector, and the number of convictions that have been obtained against publicans in the neighbourhood of Liverpool.

From the enclosed letter you will perceive that the counsel for the defence insists upon having some one from the Board of Trade to prove that the Kirkdale copies of the standards have been reverified within the limit.

I should be greatly obliged if you could make it convenient to call upon Mr. Chisholm to inquire whether the Board of Trade would send an official down, if required, to prove the reverification, or whether they can give us any suggestions or assistance in the matter.

It is of the utmost importance that we should have convictions in these cases, otherwise we shall not be able in future to obtain any convictions.

The Kirkdale weights and measures were reverified on the 24th July 1867.

I should feel obliged by an early reply in order that we may be enabled to take proper steps to secure convictions.

Yours, &c.
H. W. Johnston,
County Auditor.

Messrs. De Grave & Co.,
London.

3. *Inspector of Weights and Measures, County of Lancaster, to County Auditor.*

County Constabulary Office, Old Swan,
near Liverpool, 28th June 1870.

Dear Sir,

In reply to your note offering to attend at the Kirkdale petty sessions to prove that the standard weights and measures of this division had been verified at the Exchequer within the time required by the Act of Parliament, I have to state that on my saying in my evidence that this could be done by the production of the indenture in the way you suggest, Mr. Gully, barrister, who appeared for the defendant, said that the endorsement on the indenture would not be evidence, and that it would be necessary for some one from the Exchequer, or wherever the standards were verified, to attend and prove the fact. The case was then adjourned until the next sessions on the 8th prox., on the advice of the magistrates' clerk, to enable him to look

Appendix XIV.—*continued.*

into the question, and to-day I received a note from him saying that it would be necessary for some one to attend, as stated by Mr. Gully. I have therefore to-day reported the matter to the chief constable, and now await his instructions, before incurring so serious an expense. I do not think I was quite smart enough, or I might just with as much right have objected to Mr. Gully appearing in the matter until he had proved he was a barrister; this is in reference to another of his objections, that there was no proof that I was the properly appointed Inspector for the district, although I have performed the duties unquestioned for very nearly 14 years.

Yours, &c.
W. Martin,
Superintendent.

Mr. Johnston,
County Auditor.

4. *Warden of the Standards to County Auditor, Lancaster.*

7, Old Palace Yard, Westminster,
30th June 1870.

Sir,

Your letter of yesterday's date to Messrs. De Grave & Co. has been referred to me by them, with a request that a reply should be sent direct to you.

The endorsement upon the original indenture of verification of every new comparison and verification in the Standards Office, is in strict accordance with the requirements of s. 5 of the Act 5 & 6 Will. 4. c. 63; which requires also that an account or register be kept of every verification at this department of any copy of the Imperial standard weights and measures.

It appears that seven sets of copies of the Imperial standard avoirdupois weights and three sets of measures of capacity were reverified here for the county of Lancaster on 23rd December 1867, no special district of the county being stated; and the required endorsement was made upon the original indentures of verification. These copies may be identified by bearing the stamped number corresponding with the number of the indenture.

It appears also that a set of copies of the Imperial standard measures of capacity from one quart to half a gill, were reverified *for the Kirkdale division* of the county of Lancaster on 24th July 1867, when a *new Indenture,* No. 1,410, was issued with them. These copies bear the stamp number 1,410, and can thus be at once identified.

On the same day, a full set of avoirdupois weights and of measures of capacity were reverified for the county of Lancaster, the reverification being endorsed on the original Indenture No. 999.

The chain of evidence would seem therefore to be conclusive to establish the legality of the Lancashire copies of the standards, bearing the number corresponding with the official indenture of verification, and the stamp of the Standards Department, without the further evidence of an officer from this department. It is in my opinion out of the question that such an officer should be called upon to attend at any court of justice throughout the kingdom to give evidence in any charge of defective weights and measures, as to the legality of the local standards, when their legality can thus be so clearly established.

But, of course, if it should be considered by a legal authority to be necessary for the purposes of public justice, that an officer from this Department should attend under these circumstances to give evidence, upon a subpœna being sent, and it being understood that his expenses are to be paid, I shall at once request the instructions of the Board of Trade to authorise his attendance.

At any rate, I have to request that you will inform me of any further proceedings in the matter, and particularly whether any authoritative legal opinion be given as to the insufficiency of the present mode of endorsing the reverification upon the original indenture.

I am, &c.
H. W. Chisholm,
Warden of the Standards.

H. W. Johnston, Esq.

5. *Report of Warden of the Standards to the Board of Trade.*

7, Old Palace Yard,
4th July 1870.

Sir,

I request to call the immediate attention of the Board of Trade to a legal point which has just been raised, respecting the validity of the official indenture of verification, and the certificate of reverification endorsed upon it, to prove that local standard weights have been duly verified, in order to ensure convictions of persons charged before a court of justice with using or possessing illegal weights and measures.

Nos. 1, 2, 3, 4. The point has been raised, as may be seen by the enclosed correspondence.

I beg to suggest that the opinion of the Law Officers of the Crown be at once taken upon this question, and with this view enclose a case to be laid before them.

No. 6. It will be seen that if the defence which has been raised should be successful, no conviction for unjust weights and measures can take place in any part of the kingdom without the evidence of an officer from this Department; in such an event, it will be obviously expedient that a short Act should at once be passed to provide for the validity of this official instrument for procuring convictions.

This case is immediate, as it comes again before the Lancashire magistrates on 8th July.

I am, &c.
H. W. Chisholm,
Warden of the Standards.

The Assistant (Commercial)
Secretary, Board of Trade.

6. *Case for opinion of Law Officers of the Crown.*

Case for the Opinion of the Law Officers of the Crown.

Under sect. 12 of 5 Geo. 4. c. 74., copies of the Exchequer standards of length, weight, and measure are to be provided for the several counties, ridings, or divisions, &c., and are to be compared and verified with the official standards, "upon payment of such fees as are at present payable upon the comparison and verification of weights and measures with the standards thereof."

There is no special legal provision for the issue of an official indenture of verification in each case; but it was the established practice to issue such an indenture, the form of which is here appended, and to charge for the stamp impressed upon it. The fee and the stamp duty have been since abolished by the Standards Act, 1866, 29 & 30 Vict. c. 82, by which Act also the custody of the standards and the performance of the duties relating to them were transferred from the Exchequer to the Board of Trade. No. 7.

Sect. 5 of 5 & 6 Will. 4. c. 63, by which Act the present system of inspection of weights and measures was established, provides for the reverification of copies of the standards from time to time, and directs that "*every new comparison and verification shall be endorsed upon the original indenture of verification.*" The certificate of reverification always bears the signature of the chief of the Standards Department, but not of any witness to the signature.

Sect. 28 of 5 & 6 Will. 4. c. 28. requires the local Inspectors to examine weights and measures used in public trade, "and to compare and try the same with the copies of the Imperial Standard weights and measures required or authorized to be provided under this Act," and persons in whose possession any unjust weights and measures are found, are made liable on conviction to a penalty.

The Act 5 & 6 Will. 4. c. 63. recites the previous Act 5 Geo. 4. c. 74., and contains similar provisions in s. 17, for providing copies of the official standards for the use of the local Inspectors.

Sect. 1 of the Act 22 & 23 Vict. c. 56, for amending 5 & 6 Will. 4. c. 63, provides that no copy of the Imperial standard weights and measures shall be legal unless reverified at the Exchequer (or under certain circumstances within the county) within the respective periods of five and ten years before the time when it is used.

A question has arisen "Whether the production before the magistrates of the original indenture of verification, or of the certificate of reverification endorsed upon it, bearing the signature of the chief officer of the Standards Department, is sufficient to prove that the local standard specified in such indenture or certificate of endorsement have been duly verified according to law, or whether the personal evidence of an officer from the Standards Department is requisite for this purpose."

Your opinion is requested accordingly.

7. *Form of Official Indenture of Verification, with Certificate of Reverification endorsed.*

Form of Official Indenture of Verification.

No.

This indenture witnesseth that had and received at the Standard Weights and Measures Department of the Board of Trade at Westminster from the hands of the Warden of the Standards, pursuantly to the Act 29 & 30 Vict. c. 82, entitled "An Act to amend the Acts relating to the Standard Weights and Measures and to the Standard Trial Pieces of the Coin of the Realm," the several weights and measures following (conformably to the several Acts for

Appendix XIV.—*continued.*

regulating and assimilating the weights and measures of the United Kingdom), vizt:

All of which weights and measures have been compared with and verified by Her Majesty's standard weights and measures in the said Department of the Board of Trade, and are stamped and issued for the use of and are to be delivered to the custody of and h successor in office, to be kept and used according to the statutes in that case made and provided. In witness whereof to one part of these presents remaining in the said Standard Weights and Measures Department hath put his hand and seal, and to the other part the seal of the said Department is affixed. Given this day of in the year of the reign of Her Majesty Queen Victoria, and in the year of our Lord one thousand eight hundred and

Signed and delivered (having
first been duly sealed) in
the presence of

Warden of the Standards.

Witness ______________

Form of Official Certificate of Reverification, endorsed upon the original Indenture.

I hereby certify that the following copies of the Standard have been compared with and verified by the standards of the viz.:

Dated

8. *Opinion of Attorney and Solicitor General.*

OPINION.

We are of opinion that the production before the magistrate of the original indenture of verification, or of the certificate of reverification endorsed upon it, bearing the signature of the chief officer of the Standards Department, is sufficient to prove that the local standards therein specified have been duly verified, and that the personal evidence of the officer from the Standards Department is not necessary.

R. P. COLLIER.
J. D. COLERIDGE.

Temple,
7th July 1870.

APPENDIX XV.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—On the STANDARD TEMPERATURE and BAROMETRIC PRESSURE in COMPARISONS of STANDARD WEIGHTS AND MEASURES.

CONTENTS.

Page
Importance of determining uniform Standard Temperature and Barometric Pressure in comparison of Standards 210
Table of Standard Temperatures and Pressures now used in Standards Department - - - - - - „
Others generally adopted in this country - - - 211
Fahrenheit's Thermometric Scale recited in all Weights and Measures Acts - - - - - - 211
Inexpediency of changing this Scale - - - „
Proposed Resolutions of Commission for adopting more uniform Standard Temperature and Pressure - - „

On the Standard Temperature and Barometric Pressure in Comparisons of Standard Weights and Measures.

Importance of this question.

THE question of the establishment of a uniform normal thermometric temperature and barometric pressure for comparisons of standard weights and measures may be considered to be of importance and deserving the attention of the Standards Commission.

Table of standard temperatures and pressure now used in Standards Department.

The following Table shows the various Standard Temperatures and Barometric Pressures now adopted in the Standards Department. The equivalent Thermometric and Barometric scales are shown in Italics.

Standard Weight or Measure.	Authority.	Weighed in a Vacuum.	In Air.			
			Thermometer.		Barometer.	
			Fahr.	Centigr.	Imperial.	Metric.
					in.	mm.
Imperial yard - -	18 & 19 Vict. c. 72. - - - -	—	62°	*16°·66*	—	—
Standard metre - -	Law, 18 Germinal, An VIII. *See* Second Report of Commission -	—	*32°*	0°	—	—
Imperial pound - -	Act 18 & 19 Vict. c. 72. and Professor Miller's Report, p. 769 and p. 945.	In a vacuum.	—	—	—	—
Commercial Standard Imperial pound and official Standard Imperial weights, including 10 lbs. weight of gallon of water	Do., p. 769 and 945* - - -	—	*65°·66*	18°·7	*29·75*	755·64
Standard platinum kilogramme - -	Do., p. 885 - - -	In a vacuum.	—	—	—	—
Exchequer gilt gun-metal kilogramme and official Standard metric weights	Do., p. 937 - - -	—	*65°·66*	18°·7	*29·75*	755·64
Imperial Standard gallon -	5 Geo. 4. c. 74 - - -	—	62°	*16°·66*	30°	*761·99*
Standard litre - -	*See* Second Report, Appendix, p. 37. For the temperature of the water -	—	*39·1*	4°	—	—
	For the weight - - -	In a vacuum.	*32°*	0°	—	—

---

* The standard air *t.* 18·7° C., *b.* 755·64, taken by Professor Miller, was the mean during Schumacher's comparisons at Somerset House of his platinum Standard Troy pound and the platinum pound of the Royal Society from 21st June to 4th August 1829. The weight of the new Imperial Standard pound was based on these two platinum Troy pounds.

Appendix XV.—*continued.*

Others generally adopted in this country. Elements of Chemistry, Part I., p. 41.

In experiments for the determination of specific gravities it is stated by Dr. W. A. Miller that—

"In exact experiments the temperature of the water should be noted, 4° C. being that to which such comparisons are referred, though the temperature of 60° F. (*15·56° C.*) hitherto used in England is practically more convenient, because more easily attained."

Again, p. 263,—

"In England all comparisons of gases are usually referred to the temperature of 60° F." (*15·56° C.*)

Smithsonian Tables, p. 131.

In the psychrometrical tables of Mr. Glaisher, which are much used in England, the weight of a cubic foot of air at 32° F., and under the barometric pressure of 30 inches, has been adopted.

British Pharmacopœia, p. 393.

In volumetric estimations, for British weights and measures a flask is used "which when filled to a mark on "the neck contains exactly 10,000 grains of distilled water "at 60° F."

"It is customary to make the measurements with metrical apparatus at 60° F."

p. 394.

"All measurements of volumetric solutions should be made at 60°."

In all scientific observations of the height of the British barometer, whilst the standard temperature of the metal or glass scale is reduced to 62° F., the mercury is reduced to the temperature of 32° F., or freezing point. In the French barometer the temperature of all the component parts is reduced to 0° C.

Fahrenheit scale recited in all Weights and Measures Acts.

It may be observed that in all Acts of Parliament reciting a definite temperature, Fahrenheit's scale is adopted.

In the Weights and Measures Act of 1824, 5 Geo. 4. c. 74, by s. 1 the Imperial standard yard is declared to be the length defined on the brass standard bar, "the brass being "at the temperature of sixty-two degrees by *Fahrenheit's* "thermometer."

By s. 5, the weight of a cubic inch of distilled water is declared "weighed in air by brass weights, at the tempera-"ture of sixty-two degrees of *Fahrenheit's* thermometer, the "barometer being at thirty inches."

By s. 5. the capacity of the gallon is declared in similar terms.

Under s. 2. of the Act of 1855 for legalising the restored Imperial standards, the yard is to be taken "at the tem-"perature of sixty-two degrees by *Fahrenheit's* thermo-"meter."

In the Sale of Gas Act, 1859, 22 & 23 Vict. c. 66. the unit of measure for the sale of gas by meter is declared to be the cubic foot containing 62·321 lbs. of distilled water "weighed in air at the temperature of sixty-two degrees "of *Fahrenheit's* thermometer, the barometer being at "thirty inches." There is no declared legal standard temperature or barometric pressure of air *for the measurement of gas* in the Sale of Gas Act, or of temperature of the gas itself, but, as has been already observed in Paper XX., p. 3, the capacities of the gas measuring standards and of their copies has always been ascertained at the temperature at which the capacity of the cubic foot is determined.

nexpe- iency of hanging his scale.

In the tables of reduction of weighings compiled by Professor Miller and adopted in the Standards Department for comparisons of standard weights, the centigrade thermometric scale is employed, and the metric scale of the barometer. Although the Department is supplied with many centigrade thermometers, yet most of the thermometers are on Fahrenheit's scale, and the readings have consequently to be converted to the centigrade for using Professor Miller's tables. As the last-mentioned scale is generally used for scientific purposes, both in this country and abroad, the question has been raised, whether it would not be expedient to use the centigrade scale exclusively in the Standards Department and to substitute it for Fahrenheit's scale in the Weights and Measures laws. Considering, however, that the Imperial standard of length is defined by law to be the measure of the bronze standard bar at the temperature of 62° Fahrenheit, and that there can be no question of altering this standard length, and also that the equivalent on the centigrade scale is not an integer, being $16\frac{2}{3}$° C., it will probably be deemed inexpedient to recommend any change from the Fahrenheit scale.

Proposed resolutions of Commission for more uniform practice.

It is now suggested that the Standards Commission should express their opinion upon this subject, with a view to the adoption of a more uniform practice, to the following effect:—

Considering that with respect to all comparisons in air of Standard Imperial Weights and Measures in which scientific accuracy is needed, it is desirable to adopt both in the Standards Department, and generally in this country, a more uniform normal temperature and barometric pressure, to which the several comparisons shall be reduced,—

> We are of opinion that whilst, in the case of primary standard weights, it is necessary to reduce all weighings to the weight in a vacuum, in all cases of weighing either Imperial or metric weights in air, when the weighings are required to be reduced to air of a normal thermometric temperature and barometric pressure, the standard temperature of 62° F. (*=$16\frac{2}{3}$° C.*), and the standard barometric pressure of 30 inches, (*=$761{\cdot}986^{mm}$*), at or to be reduced to the temperature of 32° F., be adopted, and that all commercial weights be regulated accordingly.
>
> That whilst for the primary standard metre, the French standard temperature of 0° C., or 32° Fahr., be taken, at which temperature the official standard metre is laid down, all departmental comparisons with the official standard metre be made at ordinary temperatures of the air, in like manner as comparisons with the official Imperial standard measure of length, the standard temperature for all such comparisons being taken to be 62° Fahr.
>
> That in all determinations of standard imperial measures of capacity, either for dry goods, liquids, or gases, the above-mentioned standard temperature of 62° F. and barometric pressure of 30 inches be adopted, and that this standard temperature be applicable to the temperature of the air, liquid, or gas, to be noted in such determinations.
>
> That, with regard to metric measures of capacity, whilst the standard capacity of the primary standard measures of each denomination be determined with reference to their metric weight of water at its maximum density (generally taken at 4° C., or 39·2° F.), contained in each standard measure respectively, all comparisons with these standards of local standards or commercial measures be made at ordinary temperatures, the standard ordinary temperature both of the air and of the water contained in such measures being taken to be 62° F.
>
> That it is expedient that provision be made by law for the adoption of such normal temperature and barometric pressure.

H. W. CHISHOLM,
Warden.

Standards Department,
15 July 1870.

APPENDIX XVI.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—SCALE of ERRORS to be ALLOWED in the OFFICIAL COMPARISON of COPIES of the STANDARD IMPERIAL WEIGHTS and MEASURES.

NOTES.—In the comparison of Copies of the Standard Weights and Gas Measuring Standards, the amount of error to be allowed in excess is double the amount of error allowed in deficiency. In the comparison of copies of the Standard Measures of length and of capacity, the same amount of error is allowed in excess and in deficiency. *See* Observations of the Warden of the Standards, p. 409 of Appendix XII. to Fourth Report of the Standards Commission.

The proportionate allowance of error is stated not only in a fractional form, but also approximately in a decimal form, as nearly as the various scales adopted in the Imperial system, either duodecimal, decimal, septenary, or binary, will admit.

COPIES OF IMPERIAL STANDARD WEIGHTS.

Denomination of Standard Weight.	Remedy or Allowance for Error.					
	In Excess.			In Deficiency.		
	Actual Allowance.	Proportion of the whole Quantity.		Actual Allowance.	Proportion of the whole Quantity.	
	Grains.	Fractional.	Decimal.	Grains.	Fractional.	Decimal.
Avoirdupois:						
56 lb.	5·0	$\frac{1}{78400}$	0·000013	2·5	$\frac{1}{156800}$	0·000006
28 ,,	,,	$\frac{1}{39200}$	0·000026	,,	$\frac{1}{78400}$	0·000013
14 ,,	,,	$\frac{1}{19600}$	0·000053	,,	$\frac{1}{39200}$	0·000026
7 ,,	2·0	$\frac{1}{24500}$	0·000040	1·0	$\frac{1}{49000}$	0·000020
4 ,,	,,	$\frac{1}{14000}$	0·000035	,,	$\frac{1}{28000}$	0·000017
2 ,,	,,	$\frac{1}{7000}$	0·000070	,,	$\frac{1}{14000}$	0·000035
1 ,,	0·25	$\frac{1}{28000}$	0·000035	0·125	$\frac{1}{56000}$	0·000017
8 oz.	,,	$\frac{1}{14000}$	0·000071	,,	$\frac{1}{28000}$	0·000035
4 ,,	,,	$\frac{1}{7000}$	0·000142	,,	$\frac{1}{14000}$	0·000071
2 ,,	,,	$\frac{1}{3500}$	0·000285	,,	$\frac{1}{7000}$	0·000142
1 ,,	,,	$\frac{1}{1750}$	0·000571	,,	$\frac{1}{3500}$	0·000275
8 drm.	0·05	$\frac{1}{4375}$	0·000230	0·025	$\frac{1}{8750}$	0·000110
4 ,,	,,	$\frac{1}{2187}$	0·000460	,,	$\frac{1}{4374}$	0·000230
2 ,,	,,	$\frac{1}{1094}$	0·000920	,,	$\frac{1}{2188}$	0·000460
1 ,,	,,	$\frac{1}{547}$	0·001830	,,	$\frac{1}{1094}$	0·000910
½ ,,	,,	$\frac{1}{273}$	0·003660	,,	$\frac{1}{546}$	0·001880
Postal weights.						
⅓ oz.	,,	$\frac{1}{2916}$	0·000344	,,	$\frac{1}{5832}$	0·000172
⅔ ,,	,,	$\frac{1}{5832}$	0·000170	,,	$\frac{1}{2916}$	0·000080
Troy:						
1 lb.	0·1	$\frac{1}{57600}$	0·000017	0·05	$\frac{1}{115200}$	0·000008
6 oz.	,,	$\frac{1}{28800}$	0·000035	,,	$\frac{1}{57600}$	0·000017
3 ,,	,,	$\frac{1}{14400}$	0·000070	,,	$\frac{1}{28800}$	0·000035
2 ,,	,,	$\frac{1}{9600}$	0·000105	,,	$\frac{1}{19200}$	0·000052
1 ,,	,,	$\frac{1}{4800}$	0·000210	,,	$\frac{1}{9600}$	0·000105
10 dwt.	0·05	$\frac{1}{4800}$	0·000210	0·025	$\frac{1}{9600}$	0·000105
5 ,,	,,	$\frac{1}{2400}$	0·000420	,,	$\frac{1}{4800}$	0·000210
3 ,,	,,	$\frac{1}{1440}$	0·000790	,,	$\frac{1}{2880}$	0·000400
2 ,,	,,	$\frac{1}{960}$	0·001050	,,	$\frac{1}{1920}$	0·000510
1 ,,	,,	$\frac{1}{480}$	0·002100	,,	$\frac{1}{960}$	0·001050

Appendix XVI.—*continued.*

Copies of Imperial Standard Weights—*continued.*

Denomination of Standard Weight.	Remedy or Allowance for Error.					
	In Excess.			In Deficiency.		
	Actual Allowance.	Proportion of the whole Quantity.		Actual Allowance.	Proportion of the whole Quantity.	
	Grains.	Fractional.	Decimal.	Grains.	Fractional.	Decimal.
Troy—*cont.*						
12 grains - - -	0·025	$\frac{1}{480}$	0·00210	0·0125	$\frac{1}{960}$	0·00105
6 ,, - - -	,,	$\frac{1}{240}$	0·00420	,,	$\frac{1}{480}$	0·00210
3 ,, - - -	,,	$\frac{1}{120}$	0·00840	,,	$\frac{1}{240}$	0·00420
2 ,, - - -	,,	$\frac{1}{80}$	0·01250	,,	$\frac{1}{160}$	0·00625
1 grain - - - -	,,	$\frac{1}{40}$	0·02500	,,	$\frac{1}{80}$	0·01250
Bullion:						
500 oz. - - - -	1·0	$\frac{1}{240000}$	0·000004	0·5	$\frac{1}{480000}$	0·000002
400 ,, - - - -	,,	$\frac{1}{192000}$	0·000005	,,	$\frac{1}{384000}$	0·000002
300 ,, - - - -	,,	$\frac{1}{144000}$	0·000007	,,	$\frac{1}{288000}$	0·000003
200 ,, - - - -	,,	$\frac{1}{96000}$	0·000010	,,	$\frac{1}{192000}$	0·000005
100 ,, - - - -	0·25	$\frac{1}{192000}$	0·000005	0·125	$\frac{1}{384000}$	0·000002
50 ,, - - - -	,,	$\frac{1}{96000}$	0·000010	,,	$\frac{1}{192000}$	0·000005
40 ,, - - - -	,,	$\frac{1}{76800}$	0·000013	,,	$\frac{1}{153600}$	0·000006
30 ,, - - - -	,,	$\frac{1}{57600}$	0·000017	,,	$\frac{1}{115200}$	0·000008
20 ,, - - - -	,,	$\frac{1}{38400}$	0·000026	,,	$\frac{1}{76800}$	0·000013
10 ,, - - - -	0·025	$\frac{1}{192000}$	0·000005	0·0125	$\frac{1}{384000}$	0·000002
5 ,, - - - -	,,	$\frac{1}{96000}$	0·000010	,,	$\frac{1}{192000}$	0·000005
4 ,, - - - -	,,	$\frac{1}{76800}$	0·000013	,,	$\frac{1}{153600}$	0·000006
3 ,, - - - -	,,	$\frac{1}{57600}$	0·000017	,,	$\frac{1}{115200}$	0·000008
2 ,, - - - -	,,	$\frac{1}{38400}$	0·000026	,,	$\frac{1}{76800}$	0·000013
1 ,, - - - -	0·005	$\frac{1}{96000}$	0·000010	0·0025	$\frac{1}{192000}$	0·000005
0·5 ,, - - - -	,,	$\frac{1}{48000}$	0·000020	,,	$\frac{1}{96000}$	0·000010
0·4 ,, - - - -	,,	$\frac{1}{38400}$	0·000026	,,	$\frac{1}{76800}$	0·000013
0·3 ,, - - - -	,,	$\frac{1}{28800}$	0·000034	,,	$\frac{1}{57600}$	0·000017
0·2 ,, - - - -	,,	$\frac{1}{19200}$	0·000052	,,	$\frac{1}{38400}$	0·000026
0·1 ,, - - - -	,,	$\frac{1}{9600}$	0·000104	,,	$\frac{1}{19200}$	0·000052
0·05 ,, - - - -	,,	$\frac{1}{4800}$	0·000208	,,	$\frac{1}{96000}$	0·000104
0·04 ,, - - - -	,,	$\frac{1}{3840}$	0·000269	,,	$\frac{1}{7680}$	0·000135
0·03 ,, - - - -	,,	$\frac{1}{2880}$	0·000345	,,	$\frac{1}{5760}$	0·000172
0·02 ,, - - - -	,,	$\frac{1}{1920}$	0·000521	,,	$\frac{1}{3840}$	0·000261
0·01 ,, - - - -	,,	$\frac{1}{960}$	0·001040	,,	$\frac{1}{1920}$	0·000520
0·005 ,, - - - -	,,	$\frac{1}{480}$	0·002080	,,	$\frac{1}{960}$	0·001040
0·004 ,, - - - -	,,	$\frac{1}{384}$	0·002600	,,	$\frac{1}{768}$	*0·001300*
0·003 ,, - - - -	,,	$\frac{1}{288}$	0·003450	,,	$\frac{1}{576}$	0·001720
0·002 ,, - - - -	,,	$\frac{1}{192}$	0·005200	,,	$\frac{1}{344}$	0·002600
0·001 ,, - - - -	,,	$\frac{1}{96}$	0·010410	,,	$\frac{1}{192}$	0·005210

Appendix XVI.—*continued.*

COPIES OF STANDARD COIN WEIGHTS.

Denomination of Coin Weight.	Remedy or Allowance for Error.											
	In Excess.						In Deficiency.					
	Actual Allow-ance.	Equivalents in Metric Weight.	Proportion in Excess.				Actual Allow-ance.	Equivalents in Metric Weight.	Proportion in Deficiency.			
			Standard Weight.		Least Current Weight.				Standard Weight.*		Least Curren Weight.	
	Grains.	Grammes.	Frac-tional.	Decimal.	Frac-tional.	Decimal.	Grains.	Grammes.	Frac-tional.	Decimal.	Frac-tional.	Decin
Gold:												
Five pound -	0·005	0·000337	$\frac{1}{123274}$	0·000008	$\frac{1}{122500}$	0·000008	0·0025	0·000168	$\frac{1}{246548}$	0·000040	$\frac{1}{245000}$	0·000
Two pound -	,,	,,	$\frac{1}{49310}$	0·000020	$\frac{1}{49000}$	0·000008	,,	,,	$\frac{1}{98620}$	0·000010	$\frac{1}{98000}$	0·000
One sovereign -	0·002	0·000130	$\frac{1}{61637}$	0·000016	$\frac{1}{61250}$	0·000016	0·0010	0·000065	$\frac{1}{123274}$	0·000008	$\frac{1}{122500}$	0·000
Half sovereign -	,,	,,	$\frac{1}{30818}$	—	$\frac{1}{30562}$	—	,,	,,	$\frac{1}{61636}$	0·000016	$\frac{1}{61124}$	0·000
Silver:												
Crown - -	0·005	0·000337	$\frac{1}{87272}$	0·000011	—	—	0·0025	0·000168	$\frac{1}{174544}$	0·000006	—	—
Half-crown -	,,	,,	$\frac{1}{43636}$	0·000022	—	—	,,	,,	$\frac{1}{43636}$	0·000022	—	—
Florin - -	,,	,,	$\frac{1}{21818}$	0·000045	—	—	,,	,,	$\frac{1}{87272}$	0·000011	—	—
Shilling - -	0·002	0·000130	$\frac{1}{34909}$	0·000028	—	—	0·0010	0·000065	$\frac{1}{69818}$	0·000014	—	—
Sixpence - -	,,	,,	$\frac{1}{43636}$	0·000022	—	—	,,	,,	$\frac{1}{87272}$	0·000011	—	—
Groat - -	,,	,,	$\frac{1}{14545}$	0·000068	—	—	,,	,,	$\frac{1}{29090}$	0·000034	—	—
Threepence -	,,	,,	$\frac{1}{10909}$	0·000091	—	—	,,	,,	$\frac{1}{21818}$	0·000045	—	—
Twopence - -	,,	,,	$\frac{1}{7272}$	0·000137	—	—	,,	,,	$\frac{1}{14544}$	0·000069	—	—
Penny - -	,,	,,	$\frac{1}{3636}$	0·000274	—	—	,,	,,	$\frac{1}{7672}$	0·000138	—	—
Bronze:												
Penny - -	0·005	0·000337	$\frac{1}{29166}$	0·000034	—	—	0·0025	0·000168	$\frac{1}{58332}$	0·000017	—	—
Halfpenny -	,,	,,	$\frac{1}{17500}$	0·000057	—	—	,,	,,	$\frac{1}{35000}$	0·000028	—	—
Farthing - -	,,	,,	$\frac{1}{8750}$	0·000114	—	—	,,	,,	$\frac{1}{17500}$	0·000057	—	—

COPIES OF STANDARD DECIMAL GRAIN WEIGHTS.

Denomination of Standard Weight.	Remedy or Allowance for Error.					
	In Excess.			In Deficiency.		
	Actual Allowance.	Proportion of the whole Quantity.		Actual Allowance.	Proportion of the whole Quantity.	
Decimal Grain Standards:	Grains.	Fractional.	Decimal.	Grains.	Fractional.	Decimal.
4,000 grains - - -	0·05	$\frac{1}{80000}$	0·000012	0·025	$\frac{1}{160000}$	0·000006
2,000 ,, - - -	,,	$\frac{1}{40000}$	0·000025	,,	$\frac{1}{80000}$	0·000012
1,000 ,, - - -	,,	$\frac{1}{20000}$	0·000050	,,	$\frac{1}{40000}$	0·000025
500 ,, - - -	0·04	$\frac{1}{12500}$	0·000080	0·02	$\frac{1}{25000}$	0·000040
300 ,, - - -	,,	$\frac{1}{7500}$	0·000130	,,	$\frac{1}{15000}$	0·000060
200 ,, - - -	,,	$\frac{1}{5000}$	0·000200	,,	$\frac{1}{10000}$	0·000100
100 ,, - - -	,,	$\frac{1}{2500}$	0·000400	,,	$\frac{1}{5000}$	0·000200
50 ,, - - -	0·02	$\frac{1}{5200}$	0·000400	0·01	$\frac{1}{5000}$	0·000200
30 ,, - - -	,,	$\frac{1}{1500}$	0·000660	,,	$\frac{1}{3000}$	0·000330
20 ,, - - -	,,	$\frac{1}{1000}$	0·001000	,,	$\frac{1}{2000}$	0·000500
10 ,, - - -	,,	$\frac{1}{500}$	0·002000	,,	$\frac{1}{1000}$	0·001000
5 ,, - - -	0·01	$\frac{1}{500}$	0·002000	0·005	$\frac{1}{1000}$	0·001000

Appendix XVI.—*continued.*

Copies of Standard Decimal Grain Weights—*continued.*

Denomination of Standard Weight.	Remedy or Allowance for Error.					
	In Excess.			In Deficiency.		
	Actual Allowance.	Proportion of the whole Quantity.		Actual Allowance.	Proportion of the whole Quantity.	
Decimal Grain Standards:	Grains.	Fractional.	Decimal.	Grains.	Fractional.	Decimal.
3 grains - - -	0·01	$\frac{1}{300}$	0·0033	0·005	$\frac{1}{600}$	0·0016
2 „ - - -	„	$\frac{1}{200}$	0·0050	„	$\frac{1}{400}$	0·0025
1 „ - - -	„	$\frac{1}{100}$	0·0100	„	$\frac{}{200}$	0·0050
0·5 „ - - -	0·005	$\frac{1}{100}$	0·0100	0·0025	$\frac{1}{200}$	0·0050
0·3 „ - - -	„	$\frac{1}{60}$	0·0166	„	$\frac{1}{120}$	0·0083
0·2 „ - - -	„	$\frac{1}{40}$	0·0250	„	$\frac{1}{80}$	0·0125
0·1 „ - - -	„	$\frac{1}{20}$	0·0500	„	$\frac{1}{40}$	0·0250
0·05 „ - - -	0·0025	$\frac{1}{20}$	0·0500	0·00125	$\frac{1}{40}$	0·0250
0·03 „ - - -	„	$\frac{1}{12}$	0·0660	„	$\frac{1}{24}$	0·0333
0·02 „ - - -	0·002	$\frac{1}{10}$	0·1000	0·001	$\frac{1}{20}$	0·0500
0·01 „ - - -	„	$\frac{1}{5}$	0·2000	„	$\frac{1}{10}$	0·1000

COPIES OF STANDARD MEASURES OF LENGTH.

Denomination of Standard.	Remedy or Allowance for Error.		
	In Excess or in Deficiency.		
	Actual. Allowance.	Proportion of the whole Measure.	
End or bed measures:	Inch.	Fractional.	Decimal.
10 feet	0·05	$\frac{1}{2400}$	0·00040
6 „	„	$\frac{1}{1440}$	0·00070
3 „	0·01	$\frac{1}{3600}$	0·00030
2 „	„	$\frac{1}{2400}$	0·00040
1 „	0·005	$\frac{1}{2400}$	0·00040
1 inch	„	$\frac{1}{200}$	0·00500
Line measures:			
0 feet	0·01	$\frac{1}{12000}$	0·00008
6 „	„	$\frac{1}{7200}$	0·00014
3 „	0·005	$\frac{1}{7200}$	0·00014
2 „	„	$\frac{1}{4800}$	0·00020
1 „	„	$\frac{1}{2400}$	0·00040
1 inch and parts of an inch to 0·01 inch.	0·001	$\frac{1}{1000}$	0·00100

Note.—The larger measuring surface of local standard end or bed measures of length requires a larger allowance of error than for line measures. Although the best constructed standard end measures with spherical terminations may, by means of the Astronomer Royal's combination of three measures, be officially verified with as much accuracy as line measures, yet it is practically found by standards makers to be difficult to construct with precision an end standard measure as ordinarily made in the form of a bed measure with upright plane terminations; a large tolerance of error is consequently required.

COPIES OF STANDARD MEASURES OF CAPACITY.

Denomination of Standard Measure of Capacity.	Remedy or Allowance for Error.		
	In Excess or in Deficiency.		
	Actual Allowance.	Proportion of whole Measure.	
	Grains Weight of Water.	Fractional.	Decimal.
Bushel - -	280	$\frac{1}{2000}$	0·0005
Half bushel -	140	$\frac{1}{2000}$	0·0005
Peck - -	70	$\frac{1}{2000}$	0·0005
Gallon - -	50	$\frac{1}{1400}$	0·0007
Half gallon -	25	$\frac{1}{1400}$	0·0007
Quart - -	10	$\frac{1}{1750}$	0·0005
Pint - -	10	$\frac{1}{875}$	0·0011
Half pint - -	8	$\frac{1}{237}$	0·0042
Gill - -	„	$\frac{1}{547}$	0·0018
Half gill - -	4	$\frac{1}{273}$	0·0037
Quarter gill -	2	$\frac{1}{273}$	0·0037
Bottle measures:			
$\frac{1}{6}$ gallon -	10	$\frac{1}{1166}$	0·0008
$\frac{1}{12}$ gallon -	5	$\frac{1}{1166}$	0·0008
Burette measures, to deliver the specified weight of distilled water:			
11,666$\frac{2}{3}$ grains (or bottle of $\frac{1}{6}$ gall.)	6	$\frac{1}{1944}$	0·0005
5,833$\frac{1}{3}$ grains (or half bottle of $\frac{1}{12}$ gallon.)	4	$\frac{1}{1460}$	0·0006
7,000 grains -	„	$\frac{1}{1750}$	0·0005

Appendix XVI.—*continued.*

Copies of Standard Measures of Capacity—*continued.*

Denomination of Standard Measure of Capacity.	Remedy or Allowance for Error.		
	In Excess or in Deficiency.		
	Actual Allowance.	Proportion of whole Measure.	
	Grains Weight of Water.	Fractional.	Decimal.
Burette measures—*cont.*			
4,000 grains -	4	$\frac{1}{1000}$	0·0010
2,000 „ -	„	$\frac{1}{500}$	0·0020
1,000 „ -	„	$\frac{1}{250}$	0·0040
500 „ -	2	$\frac{1}{250}$	0·0040
300 „ -	„	$\frac{1}{150}$	0·0066
200 „ -	„	$\frac{1}{100}$	0·0100
100 „ -	1	$\frac{1}{100}$	0·0100
50 „ -	0·5	$\frac{1}{100}$	0·0100
30 „ -	„	$\frac{1}{60}$	0·0166
20 „ -	„	$\frac{1}{40}$	0·0250
10 „ -	„	$\frac{1}{20}$	0·0500
40 oz.* -	5	$\frac{1}{3500}$	0·0002
20 „ -	„	$\frac{1}{1750}$	0 0005
10 „ -	2	$\frac{1}{2187}$	0·0004

* 40 fluid ounces = 1 quart.
20 „ = 1 pint.
10 „ = 1 half pint.
5 „ = 1 gill.

Copies of Standard Measures of Capacity—*continued.*

Denomination of Standard Measure of Capacity.	Remedy or Allowance for Error.		
	In Excess or in Deficiency.		
	Actual Allowance.	Proportion of whole Measure.	
	Grains Weight of Water.	Fractional.	Decimal.
Burette measures—*cont.*			
5 oz. -	2	$\frac{1}{1093}$	0·0009
4 „ -	„	$\frac{1}{875}$	0·0011
2 „ -	„	$\frac{1}{437}$	0·0022
1 „ -	1	$\frac{1}{437}$	0·0022
$\frac{1}{2}$ „ -	„	$\frac{1}{268}$	0·0044
To deliver the specified quantity in cubic measurement of distilled water:			
10 cubic inches	1	$\frac{1}{2524}$	0·0004
5 „	„	$\frac{1}{1262}$	0·0008
2 „	„	$\frac{1}{504}$	0·0019
1 „	0·5	$\frac{1}{504}$	0·0019
0·5 „	„	$\frac{1}{252}$	0·0038
0·2 „	„	$\frac{1}{100}$	0·0100
0·1 „	„	$\frac{1}{50}$	0·0200

COPIES OF GAS MEASURING STANDARDS.

Denomination of Standard Measure of Capacity.	Remedy or Allowance for Error.			
	In Excess.		In Deficiency.	
	Actual Allowance.	Proportion of the whole Measure.	Actual Allowance.	Proportion of the whole Measure.
Gas measuring standards, including test meters, passing the specified legal quantity at one revolution or complete action:				
10 cubic feet - - - -	0·5 per cent. fast.	—	0·25 per cent. slow.	—
5 „ - - - - -				
1 „ - - - - -				

Appendix XVI.—*continued.*

PRIMARY AND SCIENTIFIC STANDARDS.—WEIGHTS.

Denomination of Standard.	Remedy or Allowance for Error.					
	In Excess.			In Deficiency.		
	Actual Allowance.	Proportion of the whole Quantity.		Actual Allowance.	Proportion of the whole Quantity.	
	Grains.	Fractional.	Decimal.	Grains.	Fractional.	Decimal.
Avoirdupois:						
1 lb. - - - -	0·0025	$\frac{1}{2800000}$	0·0000003	0·00125	$\frac{1}{5600000}$	0·0000001
1 oz. - - - -	0·0010	$\frac{1}{437500}$	0·0000020	0·0005	$\frac{1}{875000}$	0·0000010
Troy:						
1 lb. - - - -	0·002	$\frac{1}{2880000}$	0·0000003	0·001	$\frac{1}{5760000}$	0·0000001
1 oz. - - - -	0·001	$\frac{1}{480000}$	0·0000020	0·0005	$\frac{1}{960000}$	0·0000010
Decimal Grains:						
4,000 - - - -	0·01	$\frac{1}{400000}$	0·000002	0·005	$\frac{1}{800000}$	0·000001
2,000 - - - -	,,	$\frac{1}{200000}$	0·000005	,,	$\frac{1}{400000}$	0·000002
1,000 - - - -	0·005	$\frac{1}{200000}$	0·000005	0·0025	$\frac{1}{400000}$	0·000002
500 - - - -	,,	$\frac{1}{100000}$	0·000010	,,	$\frac{1}{200000}$	0·000005
300 - - - -	,,	$\frac{1}{60000}$	0·000016	,,	$\frac{1}{12000}$	0·000008
200 - - - -	,,	$\frac{1}{40000}$	0·000025	,,	$\frac{1}{80000}$	0·000012
100 - - - -	,,	$\frac{1}{20000}$	0·000050	,,	$\frac{1}{40000}$	0·000025
50 - - - -	0·002	$\frac{1}{25000}$	0·00004	0·001	$\frac{1}{50000}$	0·00002
30 - - - -	,,	$\frac{1}{15000}$	0·00006	,,	$\frac{1}{30000}$	0·00003
20 - - - -	,,	$\frac{1}{10000}$	0·00010	,,	$\frac{1}{20000}$	0·00005
10 - - - -	,,	$\frac{1}{5000}$	0·00020	,,	$\frac{1}{10000}$	0·00010
5 - - - -	,,	$\frac{1}{2500}$	0·00040	,,	$\frac{1}{50000}$	0·00020
3 - - - -	,,	$\frac{1}{1500}$	0·00066	,,	$\frac{1}{3000}$	0·00033
2 - - - -	,,	$\frac{1}{1000}$	0·0010	,,	$\frac{1}{2000}$	0·0005
1 - - - -	0·001	$\frac{1}{1000}$	0·0010	0·0005	$\frac{1}{2000}$	0·0005
0·5 - - -	,,	$\frac{1}{500}$	0·0020	,,	$\frac{1}{1000}$	0·0010
0·3 - - -	,,	$\frac{1}{300}$	0·0033	,,	$\frac{1}{600}$	0·0016
0·2 - - -	,,	$\frac{1}{200}$	0·0050	,,	$\frac{1}{400}$	0·0025
0·1 - - -	,,	$\frac{1}{100}$	0·0100	,,	$\frac{1}{200}$	0·0050
0·05 - - -	,,	$\frac{1}{50}$	0·0200	,,	$\frac{1}{100}$	0·0100
0·03 - - -	,,	$\frac{1}{30}$	0·0333	,,	$\frac{1}{60}$	0·0166
0·02 - - -	,,	$\frac{1}{20}$	0·05	,,	$\frac{1}{40}$	0·0250
0·01 - - -	,,	$\frac{1}{10}$	0·1	,,	$\frac{1}{20}$	0·05
Cubic Foot Weight:						
62·321 lbs. - - -	2	$\frac{1}{218123}$	0·000004	1	$\frac{1}{436247}$	0·000002
Gallon of Water Weight:						
lbs. - - -	0·5	$\frac{1}{140000}$	0·000007	0·25	$\frac{1}{280000}$	0·000003

Appendix XVI.—*continued.*

PRIMARY AND SCIENTIFIC STANDARD MEASURES OF CAPACITY.

Denomination of Standard.	Remedy or Allowance for Error.		
	In Excess and Deficiency.		
	Actual Allowance.	Proportion of the whole Measure.	
Cylindrical Measures :	Grains weights.	Fractional.	Decimal.
Gallon - -	10	$\frac{1}{7000}$	0·00014
Quart - - -	5	$\frac{1}{3500}$	0·00028
Pint - - -	2	$\frac{1}{4375}$	0·00022

Conical measures one-half the above allowances.

Burettes. *See* local and commercial standards. The same amount of remedy or allowance for error permitted.

Cubic foot - - -	10	$\frac{1}{43624}$	—

PRIMARY AND SCIENTIFIC STANDARD MEASURES OF LENGTH.

Denomination of Standard.	Remedy or Allowance for Error.		
	In Excess and Deficiency.		
	Actual Allowance.	Proportion of the whole Measure.	
	Inch.	Fractional.	Decimal.
End yard - - -	0·002	$\frac{1}{18000}$	0·00005
Foot - - -	,,	$\frac{1}{6000}$	0·00015
Inch - - -	0·001	$\frac{1}{1000}$	0·00100
Line yard - - -	0·001	$\frac{1}{36000}$	0·00003
Foot - - -	,,	$\frac{1}{12000}$	0·00008
Inch and parts to 0·01 inch.	,,	$\frac{1}{1000}$ to $\frac{1}{10}$	0·001 to 0·100
End 10 foot - -	0·005	$\frac{1}{24000}$	0·00004
6 ,, - -	,,	$\frac{1}{14400}$	0·00007
Line 10 ,, - -	0·0025	$\frac{1}{48000}$	0·00002
6 ,, - -	,,	$\frac{1}{28800}$	0·00003

It may be desirable here to state, for the purpose of comparison, the scale of errors allowed in the comparison of copies of the metric standards for the use of the local officers of verification in France, and in the North German Confederation, as shown in the papers already laid before the Commission.

2d Rep. App. 2, p. 89. 4th Rep. App. XI., p. 340.

In France, the errors are allowed by the departmental regulations *in excess* only, except in the weights of a kilogram and under in the *necessaire des Vérificateurs,* where they are allowed both in excess and in deficiency. In the North German Confederation the errors are allowed *both in excess and in deficiency.*

SCALE OF ERRORS ALLOWED IN THE COMPARISONS OF LOCAL STANDARDS IN FRANCE AND GERMANY.

—	In France.		In the North German Confederation.	
	In Excess only.		In Excess and in Deficiency.	
	Actual.	Proportional.	Actual.	Proportional.
	mm.			
1 metre - -	0·02	0·00002	0·04	0·00004
0·5 ,, or half metre	—	—	0·02	0·00004
0·2 ,, or double decimetre.	—	—		0·00010
0·1 ,, or decimetre	—	—		0·00020
	gram.		gram.	
20 kilograms - -	0·40	0·00002	0·80	0·00004
10 ,, - -	0·20		0·50	0·00005
5 ,, - -	0·10		0·25	0·00005
2 ,, - -	0·04		0·12	0·00006
1,000 grammes, or kilogram.	0·02		0·08	0·00008
500 grammes, or demi-kilogram.	,,	0·00004	0·05	0·00010
200 grammes, or double hectogram.	0·01	0·00005	0·02	
100 grammes, or hectogram.	,,	0·00010	0·012	0·00012
50 grammes, or demi-hectogram.	,,	0·00020	0·010	0·00020
20 grammes, or double dekagram.	—	—	0·006	0·00030
10 grammes, or dekagram.	—	—	0·004	0·00040
5 grammes, or demi-dekagram.	—	—	0·0025	0·00050
2 grammes, or double gramme.	—	—	0·00125	0·000625
1 gramme - -	—	—	0·0008	0·00080
0·5 gramme, or demi-gram.	—	—	0·0004	0·00080
0·2 gramme, or double decigram.	—	—		0·00200
0·1 gramme, or decigram.	—	—		0·00400
20 litres, or double dekalitre.	4·00	0·00020	20·00	0·001
10 ,, or dekalitre	2·00		10·00	
5 ,, or demi-dekalitre.	1·00		5·00	
2 ,, or double litre.	0·40		2·00	
1 ,, - - -	0·2		1·00	
0·5 litre, or demi-litre	0·1		1·00	0·002
0·2 ,, or double decilitre.	0·04		0·40	
0·1 ,, or decilitre	0·02		0·40	0·004
0·05 ,, or demi-decilitre.	0·10		0·20	
0·02 ,, or double centilitre.	0·004		0·08	
0·01 ,, or centilitre	0·002		—	—

Note.—In France and in the North German Confederation there is also a definite allowance for errors in the verification of commercial weights and measures of the metric system.

Appendix XVI.—*continued.*

In France the proportionate allowance for errors as between local standards and commercial weights and measures varies according to the weight or measure tested.

For brass commercial weights the average tolerance is five times that for local standards, and for iron weights it is about six times that for brass weights. For a commercial metre made of metal the tolerance is ten times that for a local standard metre, and for a wooden metre five times that for a metallic measure. For metal measures of capacity of a litre and upwards the allowance is ten times that for local standards, and this proportionate rate increases progressively for the smaller measures up to one hundred times for the measure of a centilitre. The tolerance for all wooden measures of capacity is $\frac{1}{100}$th part.

In the North German Confederation the proportionate allowance for errors in the verification of metric weights of precision is 2·5 times that for local standard weights, and this allowance is doubled in the verification of trade weights, and again doubled for trade weights in actual use. The allowance for length measures of precision is 2·5 times that for local standards, and five times the allowance for measure of precision is made for ordinary trade measures of metal or ivory, which is further doubled for wooden measures. For metric measures of capacity made of metal the allowance is ten times that for the local standard measures, and this allowance is doubled for wooden measures of capacity.

Standards Department,
30th July 1870.

H. W. CHISHOLM,
Warden.

APPENDIX XVII.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—On the NUMBER and DENOMINATIONS of LEGAL SECONDARY STANDARDS of WEIGHTS and MEASURES.

CONTENTS.

Page
List of Exchequer Standards transferred to Board of Trade 219
Alterations in the number of Standards recommended by the Standards Commission - - - - ,,
And directed in the Coinage Act, 1870 - - - ,,
List of proposed legal secondary Standards of Weights and Measures - - Imperial system 220
Metric system - 221
Recapitulation - - - - - - - 222
Probable number of Standards required by local officers - ,,
Auxiliary graduated Standards of capacity - - ,,

List of Exchequer Standards transferred to Board of Trade.

The existing number of denominations of legal secondary standards which were transferred from the Exchequer to the Board of Trade, and are now used in the Standards Department for the comparison and verification of copies for the use of the local Inspectors of weights and measures, has already been shown in Paper I. laid before the Standards Commission, and proposed as Appendix II. to the fifth Report. The list is as follows:—

LIST of the STANDARDS of WEIGHTS and MEASURES, in use at HER MAJESTY'S EXCHEQUER, up to 1866, and transferred to the BOARD of TRADE.

Weights.			Measures.		Gas Standards.	
	Troy.				22 & 23 Vict. c. 66.	
Avoirdupois.	5 Geo 4. c. 74.	16 Vict. c. 29. Bullion.	Of Extension.	Of Capacity.	Weight.	Measure.
56 lbs.	1 lb.	500 oz.	Yard.	Bushel.	62·321 lbs. weight of cubic foot of distilled water at 60°.	Cubic foot bottle.
28 ,,	6 oz.	400 ,,		½ ,,		10 ft. gas-holder.
14 ,,	3 ,,	300 ,,		Peck.		5 ,,
7 ,,	2 ,,	200 ,,		Gallon.		1 ,,
4 ,,	1 ,,	100 ,,		½ ,,		
2 ,,	10 dwts.	50 ,,		Quart.		
1 ,,	5 ,,	40 ,,		Pint.		
8 oz.	3 ,,	30 ,,		½ ,,		
4 ,,	2 ,,	20 ,,		Gill.		
2 ,,	1 ,,	10 ,,		½ ,,		
1 ,,	12 grs.	5 ,,				
8 drs.	6 ,,	4 ,,				
4 ,,	3 ,,	3 ,,				
2 ,,	2 ,,	2 ,,				
1 ,,	1 ,,	1 ,,				
½ ,,		0·5 ,,				
		0·4 ,,				
		0·3 ,,				
		0·2 ,,				
		0·1 ,,				
		0·05 ,,				
		0·04 ,,				
		0·03 ,,				
		0·02 ,,				
		0·01 ,,				
		0·005 ,,				
		0·004 ,,				
		0·003 ,,				
		0·002 ,,				
		0·001 ,,				
16	15	30	1	10	1	4

Total number of standards - - - - 77.

There is also a 10 lb. standard weight, used for the verification of the standard gallon, the unit of capacity. But the 10 lb. standard weight has never been used for the comparison and verification of other 10 lb. weights, nor is a 10 lb. weight ever comprised in a set of avoirdupois local standard weights, verified for the use of Inspectors of weights and measures.

Alterations in the number of Standards recommended by Standards Commission,

In their first Report, the Standards Commission recommended the following additions to the number of legal secondary standards:—

In weights of the smaller class:—standards of decimal series of grain weights; and standards of the weights of the half-sovereign, and of decimal series of the sovereign (gold coins), showing their full legal weight; together with single standards, showing the smallest weight sanctioned in legal tolerance.

In measures of length:—standards of the chain of 22 yards divided into links; the measure of 100 feet divided into feet; the measure of 10 feet with decimal and duodenary subdivisions; the measures of one yard, of two feet, and of one foot, with binary and other subdivisions.

In measures of capacity:—standards of $\frac{1}{6}$ gallon and $\frac{1}{12}$ gallon, as measures of the wine-bottle and half wine-bottle; and standards of 4, 2, and 1 fluid avoirdupois ounces (of distilled water).

A measure (with proper comparing apparatus) of 1 yard, bearing various subdivisions, has been provided; which, when verified as to its whole length and its divisions by the Warden of the Standards, might with propriety be used as an Official Standard, for accurate comparisons of subdivided measures.

In their second Report the Commission recommended the legalisation of a complete set of metric standards.

In their third Report, they recommended that the standard weights of the troy system, including the decimal bullion weights, should cease to be legal secondary standards; and that in addition to the decimal series of avoirdupois grain weights, from 0·01 grain to 1,000 grains, recommended to be legalised in their first Report, standard weights of 2,000 and 4,000 grains should also be legalised.

In their fourth Report, they recommended the legalisation of standard weights of ⅓ and ⅔ oz. avoirdupois, for foreign postal services, and these weights have since been constituted legal secondary standards by Her Majesty's Order in Council, dated 4th June 1870, notified in the London Gazette of 7th June 1870, in pursuance of s. 6 of the Standards Act, 1866.

and directed in Coinage Act, 1870.

The standard weights of each coin of the realm, required to be constructed under s. 17 of the Coinage Act, 1870, 33 Vict. c. 10, and when duly verified to be constituted by Her Majesty in Council, as the standard weights for determining the justness of the weight of, and for weighing such coin, are specified in the first schedule to the Act.

For the smaller standard measures of capacity for liquids, both on the imperial and the metric system, complete series of glass burettes have been constructed by Messrs. Griffin. These burettes are cylindrical in form, narrowed at the lower end to a small orifice, and having the upper part reduced to a small tube, upon which the standard measure is defined by a cut line. Each burette, except those of the smallest capacity, is fitted at its upper extremity with a brass socket and a screw by which it can be attached to a suitable stand and filled with water exactly up to the defining line, and it is intended not to hold but *to deliver* the exact measure of pure water at the standard temperature. The smallest burettes are used in the hand and the upper orifice closed with the finger.

The construction of these burette measures is referred to in the minutes of the 22nd meeting of the Commission (§ 16), the 23rd meeting (§ 13), the 24th meeting (§ 3), and the 28th meeting (§ 9).

List of proposed legal secondary Standards of Weights and Measures.

With reference to resolution (127), contained in § xxxviii. of the fourth Report of the Commission,—

That tables of all the denominations of legal weights and measures be appended in a schedule to the proposed bill for amending and consolidating the laws relating to weights and measures, and the standards of weight and measure; the following list of legal secondary standards is suggested for the consideration of the Commission:—

Appendix XVII.—*continued.*

LIST of PROPOSED LEGAL SECONDARY STANDARDS of WEIGHTS and MEASURES.—To be deposited in the Standards Department of the Board of Trade, and to be duly verified in relation to the primary standards of the imperial and metric systems, and to be used for comparing and verifying copies of these standards for the local officers of weights and measures and other persons.

IMPERIAL SYSTEM.

Description.	No.	Denominations.	Remarks.
WEIGHTS.			
Avoirdupois	16	56, 28, 14, 7, 4, 2, 1 lbs. 8, 4, 2, 1 oz. 8, 4, 2, 1, ½ dr.	Legalised by 5 Geo. 4. c. 74.
Decimal grain	23	4,000, 2,000, 1,000 gr. 500, 300, 200, 100 gr. 50, 30, 20, 10 gr. 5, 3, 2, 1 gr. 0·5, 0·3, 0·2, 0·1 gr. 0·05, 0·03, 0·02, 0·01 gr.	To be legalised by H.M. Order in Council.
Foreign postal	2	⅓ and ⅔ oz.	Legalised by H.M. Order in Council, 7th June 1870.
For coin	16	Metric Weight.	To be legalised by H.M. Order in Council.
		Gold—*Standard Weight*:—	
		Five pound - 616·37239 grains = 39·94028 grammes	
		Two pound - 246·54895 „ = 15·97611 „	
		Sovereign - 123·27447 „ = 7·98805 „	
		Half sovereign 61·63723 „ = 3·99402 „	
		Gold—Least Current Weight:—	
		Five pound - 612·50000 „ = 39·68935 „	
		Two pound - 245·00000 „ = 15·87574 „	
		Sovereign - 122·50000 „ = 7·93787 „	
		Half sovereign 61·12500 „ = 3·96083 „	
		Silver:—	
		Crown - - 436·36363 „ = 28·27590 „	
		Half crown - 218·18181 „ = 14·13795 „	
		Florin - - 174·54545 „ = 11·31036 „	
		Shilling - 87·27272 „ = 5·65518 „	
		Sixpence - 43·63636 „ = 2·82759 „	
		Groat or fourpence - 29·09090 „ = 1·88506 „	
		Threepence - 21·81818 „ = 1·41379 „	
		Twopence - 14·54545 „ = 0·94253 „	
		Penny - - 7·27272 „ = 0·47126 „	
		Bronze:—	
		Penny - - 145·83333 „ = 9·44984 „	
		Halfpenny - 87·50000 „ = 5·66990 „	
		Farthing - 43·75000 „ = 2·83495 „	
Of gallon measure of distilled water	1	10 lbs.	By 5 Geo. 4. c. 74.
Of cubic foot measure of distilled water	1	62·321 lbs.	By Sale of Gas Act, 1859.
Total number of legal denominations of imperial standard weights	59		

Description.	No.	Denominations.	Remarks.
MEASURES OF CAPACITY.			
For liquids or dry commodities	11	Bushel, half bushel, peck, gallon, half gallon, quart, pint, half pint, gill, half gill, quarter gill	Legalised by 5 Geo. 4. c. 74. The bushel and peck being equal for liquids to 8 and 2 gallons. The quarter gill is proposed as a new standard measure, and should be legalised by H.M. Order in Council.
For bottle measures	2	⅙ gallon, or standard bottle $\frac{1}{12}$ „ or standard half bottle	Glass burette measures, to be legalised by H.M. Order in Council.
Fluid ounce measures	4	4 oz., 2, 1, and ½ oz.	Do. Being in addition to— Quart = 40 ounces. Pint = 20 „ Half pint = 10 „ Gill = 5 „ *Half gill* = 2½ „
Liquid measures of grain weights of distilled water	16	7,000, 4,000, 2,000, 1,000 grains 500, 300, 200, 100 „ 50, 30, 20, 10 „ 5, 3, 2, 1 „	Do. *Note.*—7,000 gr. = ⅒ gallon. or ⅘ pint. 1,000 gr. = $\frac{1}{70}$ gallon. The decimal scale of 5, 3, 2, 1, was adopted by the Commission on 21st Dec. 1869. See s. 5. of Minutes.
Cubic inch measures	7	10, 5, 2, 1, 0·5, 0·2, 0·1 cubic inch	Do. *Note.*—10 cub. in. = 2524·58 gr. 5 „ = 1262·29 „ 2 „ = 504·916 „ 1 „ = 252·458 „
Gas measuring standards	3	10, 5, and 1 cubic foot measurers	Legalised by Sale of Gas Act, 1859.
	2	Test-meter, to pass 5 cubic feet at one revolution, „ „ 1 cubic foot „	To be legalised by H.M. Order in Council.
Total number of legal denominations of standard measures of capacity	45		

Appendix XVII.—*continued.*

Description.	No.	Denominations.	Remarks.
Measures of length	7	100 feet chain, divided into tenths of 10 feet each	To be laid down as public standards.
		66 ,, of 100 links, divided into tenths of 10 links each	
		10 feet, divided into feet	Also to be exhibited (without divisions) as public mural standards. *Note.*—The yard only is now a legal standard. The other measures of length should be legalised as secondary standards by Her Majesty's Order in Council.
		6 ,, ,, ,,	
		3 ,, or yard, divided into feet, and nails or sixteenths	
		2 ,, divided into feet and inches	
		1 foot, divided into inches, and one inch decimally into tenths and hundredths; into twelfths; binarily into sixteenths	
Total number of legal denominations of standard measures of imperial length	7		

Metric System.

Weights	23	20, 10, 5, 2, 1 kilogram, or 1,000 grammes in decimal series	All the metric weights and measures to be legalised by Act of Parliament. *Note.*—There is a duplicate unit in each decimal series, to make up the number 9.
		500, 200, 100 grammes or hectogram	
		50, 20, 10 ,, or dekagram	
		5, 2, 1 ,, ,,	
		0·5, 0·2, 0·1 ,, or centigram	
		0·05, 0·02, 0·01 ,, or decigram	
		0·005, 0·002, 0·001 ,, or milligram	
Total number of legal denominations of standard metric weights	23		
Measures of capacity	13	Hectolitre = 100 litres	The whole series of these standard measures are cylindrical, and are used for liquids. For dry commodities the demi-decilitre is the smallest cylindrical measure used.
		Demi-hectolitre = 50 ,,	
		Double dekalitre = 20 ,,	
		Dekalitre = 10 ,,	
		Demi-dekalitre = 5 ,,	
		Double litre = 2 ,,	
		Litre = 1 ,,	
		Demilitre = 0·5 litre	
		Double decilitre = 0·2 ,,	
		Decilitre = 0·1 ,,	
		Demi-decilitre = 0·05 ,,	
		Double centilitre = 0·02 ,,	
		Centilitre = 0·01 ,,	
		Note.—Litre = 1 cubic decimetre, or 1,000 cubic centimetres, or 1,000 grammes weight of distilled water at its maximum density.	There are also seven glass burettes of these denominations as standard measures of metric capacity for delivering the specified quantities of water or other liquids, as well as the smaller measures of 5, 2, and 1 cubic centimetres.
		Demilitre = 500 cubic centimetres or grammes weight.	
		Double decilitre = 200 ,, ,,	
		Decilitre = 100 ,, ,,	
		Demi-decilitre = 50 ,, ,,	
		Double centilitre = 20 ,, ,,	
		Centilitre = 10 ,, ,,	
	3	5, 2, 1 cubic centimetres or grammes weight of distilled water.	
Total number of denominations of metric measures of capacity	16		
Measures of length	6	Chain of double dekametre, or 20 metre, divided	To be laid down as public standards.
		into dekametre or 10 ,,	
		demi-dekametre or 5 ,,	
		double metre or 2 ,,	
		metre or 1 ,,	
		Double metre,	The units of the metre, half metre, double decimetre, decimetre, and centimetre, to be exhibited as public standards.
		Metre divided into 10 decimetres	
		Half metre ,, into 5 decimetres	
		Double decimetre,	
		Decimetre divided into 10 centimetres	
		1 centimetre ,, into 10 millimetres	
Total number of metric measures of length	6		

Appendix XVII.—*continued.*

Recapitulation.

Standards of Imperial System.

Weights:—			
Avoirdupois	16		
Decimal grain	23		
Foreign postal	2		
Coin (also metric)	16		
Gallon weight	1		
Cubic foot weight	1		
		59	
Measures of capacity:—			
Liquid or dry measures	11		
Glass burettes, Bottle measures	2		
Glass burettes, Fluid ounce	4		
Glass burettes, Containing grain weights of water	16		
Glass burettes, Cubic inch	7		
Gas measures	5		
		45	
Measures of length		7	
Total standards of Imperial system			111

Standards of Metric System.

Weights	23	
Measures of capacity	16	
Measures of length	6	
Total standards of Metric system		45
Total number of legal standards		156

Probable number of standards required by local officers.

It is probable that copies of the following standards only would be required by the local officers to verify weights and measures to be used for ordinary trade purposes:—

Imperial system:			
Avoirdupois weights	16		
Decimal grain weights (1,000 grs. to 0·01)	21		
Measures of capacity	13		
Fluid ounce measures	4	5	
Graduated, 1,000 grs. to 10 grs.	1		
Gas measures	3		
Measure of length (subdivided yard)	1		
			59
Metric system:—			
Weights	23		
Measures of capacity	16		
Measure of length (subdivided metre)	1		
			40
Total			99

Auxiliar graduat standard of capaci

In addition to the standard glass burettes, each of which has been specified as delivering one exact measure, both imperial and metric, there are several auxiliary standards in the form of graduated glass pipettes, which are uniformly cylindrical, except at the lower end where they contract to a narrow orifice. These pipettes are graduated decimally, for instance:

Imperial measures:—

1,000	grains weight of water,	graduated in tenths and in hundredths of 10 grains each.
100	do.	in tenths and hundredths.
50	do.	in 20 divisions of 2½ grains.
10	do.	in 20 divisions of ½ grain.
1	do.	in 10 divisions of $\frac{1}{10}$ grain.

1 ounce in tenths.

1 cubic inch, divided into tenths.

$\frac{1}{10}$ cubic inch, divided into tenths.

Metric measures:—

25 divided into half centimetres.

25 cubic centimetres, or grammes weight of water, graduated in cubic centimetres and half centimetres.

10 cubic centimetres, in tenths and hundredths, and half tenths and hundredths.

1 cubic centimetre, in tenths and hundredths.

Graduated glass measures, such as these, will probably be much used by inspectors, chemists, and others, but it may be sufficient to constitute as legal secondary standards, those denominations of measures only which have been here specified.

H. W. CHISHOLM,
Warden.

Standards Department,
25th June 1870.

APPENDIX XVIII.

PAPER DELIVERED by the WARDEN OF THE STANDARDS.—LIST of STANDARDS and other WEIGHTS and MEASURES deposited in the STANDARDS DEPARTMENT.

CONTENTS.

Page
Various descriptions of standards and other weights and measures - 222
Imperial Standards:—
I.—Of an antiquarian or historical character, no longer used as official standards - „
II.—Of existing legal denominations, but proposed to be discontinued as official standards - „
III.—Of existing legal denominations of a primary character, or standards of reference - 223
IV.—Auxiliary standards, used in verifying standards of legal denominations - „
V.—Official standards, or legal secondary standards, for verifying copies, to be used by local Inspectors of Weights and Measures, &c. - „
Metric Standards:—
VI.—Metric standards of a primary character - 224
VII.—Official metric standards for verifying copies for local Inspectors, &c. - „
Other Standards:—
VIII.—Standards of other countries, exclusive of metric standards already described - 225
Weights and Measures:—
IX.—Specimens of commercial weights and measures, &c. - „

LIST of all the STANDARDS of WEIGHTS and MEASURES, and of SPECIMENS of COMMERCIAL WEIGHTS and MEASURES, &c., in the STANDARDS DEPARTMENT of the BOARD OF TRADE.

Various descriptions of standards, &c.

The collection of standards and other weights and measures deposited in the Standards Department, may be described under the following heads:—

Imperial standards.

(I.) Standards of an antiquarian or historical character, no longer used as official standards.

(II.) Standards of existing legal denominations, but proposed to be discontinued as legal standards, and to be classed under (I.) or (IV.).

(III.) Standards of existing legal denominations of a primary character, or standards of reference.

(IV.) Auxiliary standards, used in the verification of standards of legal denominations.

(V.) Official standards, or legal secondary standards for verifying copies to be used by local Inspectors of Weights and Measures, &c.

Appendix XVIII.—*continued.*

Metric standards.
(VI.) Metric standards of a primary character.

(VII.) Official metric standards for verifying copies for local Inspectors, &c.

Other standards, &c.
(VIII.) Standards of other countries, exclusive of metric standards already described.

Weights and measures.
(IX.) Specimens of commercial weights and measures, &c.

IMPERIAL STANDARDS.

I.—*Standards of an Antiquarian or Historical Character, no longer used as Official Standards.*

I. Imperial standards of antiquarian or historical character.

1. Measures of length:—

An octagon yard rod of latten metal, marked 𝕳, considered to be the standard of Henry VII., and having divisions of 1, 2, 3, 4, 12, and 18 inches.

A bed of bell-metal, marked E with a crown, of an ell and yard; together with a yard rod, marked E with a crown, and having divisions of 2 inches, and an ell rod 45 inches in length, marked E with a crown.

This yard bed and rod together constituted the official standard yard used for verifying local standard yards from 1588 to 1824.

Four imperial standard yards being line measures on brass bars, their defining points marked on gold studs; verified by Captain H. Kater, 1824, and constructed as standards of reference.

An imperial standard yard being a brass bar with upright steel terminations, verified by Captain Kater in 1824; together with a brass yard rod with two wooden handles attached. These were made by Mr. Bate, and were used as the official standard yard from 1824 to 1869.

2. Weights:—

An antique box covered with leather, containing the following troy weights marked "1588 E R," viz., 256, 128, 64, 32, 16, 8, 4, 2, 1, ½, ¼ oz., and two of ⅛ oz.

Four bell-shaped gun-metal weights, marked E with a rose, viz., 28, 14, 7, 2 lb.

An antique box covered with leather containing the following avoirdupois weights of bell-metal, flat shape, and marked "1588 E R"; 8, 4, 2, 1 lb.; 8, 4, 2, 1, ½, ¼, ⅛, $\frac{1}{16}$ oz.

These troy and avoirdupois weights were used as the official standards from 1588 to 1824.

A gun-metal troy lb. denoted as O, and marked "1 lb. "troy, 1758;" made by Harris for the Parliamentary Committee of Weights and Measures, and believed to be the original troy pound, from which the lost standard was made.

A set of troy weights, 12 oz. to ½ oz., marked "Harris, 1758."

A set of copper troy weights 1758, 5 dwts. to 1 grain.

A standard 1 lb. avoirdupois and a standard 1 lb. troy weight 1824, both of brass, and verified by Captain Kater as standards of reference. These were sent to the Paris Exhibition in 1867, together with the old standards of Henry VII. and of Queen Elizabeth.

3. Measures of capacity:—

Two ancient bushels of bell-metal marked "Henricus Septimus" with a rose.

Two bushels of bell-metal marked E R 1601.

These are measures of the old Winchester bushel.

A gallon marked "Henricus Septimus."

Two gallons, a quart, and pint marked E R 1601, and a pint marked E R 1602.

These standards of Queen Elizabeth were used as the official standards for verifying local standard measures of capacity, from 1601 to 1824.

A wine gallon marked "1707, wine gallon A R."

A coal bushel of bell-metal marked 4 Geo. 2.

Four cubic measures of capacity each constructed of five brass plates firmly screwed together, and marked respectively 300, 60, 12, 2 cubic inch. 1758; made by Harris for the Parliamentary Committee of Weights and Measures.

II.—*Standards of existing Legal Denominations, but proposed to be discontinued as Legal Standards, and to be classed under* (I.) *or* (IV.).

II. Imperial standards, proposed to be discontinued as legal standards.

Standard weights:—

A set of fifteen brass official standard troy weights, from 1 lb. to 1 grain, with their brass counterpoises; constructed in 1824, and used up to the present time in the verification of Inspector's Troy Standards.

A set of thirty-one official gilt gun-metal standard weights of 500, 400, 300, 200, 100, 50, 40, 30, 20, 10, 5, 4, 3, 2, 1, 0·5, 0·4, 0·3, 0·025, 0·2, 0·1, 0·05, 0·04, 0·03, 0·02, 0·01, 0·005, 0·004, 0·003, 0·002, 0·001, troy ounces, with their gun-metal counterpoise weights; constructed in 1855 in pursuance of the Bullion Act, 16 Vict. c. 29.

A set of nine brass troy weights, from 1 lb. (12 ozs.) to 30 lb. (360 ozs.); constructed in 1845, to be used for trials of the pyx.

III.—*Standards of existing Legal Denominations of a Primary Character, or Standards of Reference.*

III. Legal standards of a primary character.

1. Measures of length:—

The Imperial Standard yard, a line measure marked on gold studs sunk to the middle axis of a bronze bar of Baily's metal, and marked "No. 1 Standard yard at 62°00 Fahrenheit."

Bronze yard No. 6, distinguished as the Generator, 1844.

Yard mounted as a pendulum, soldered in a leaden case.

Yard mounted as a pendulum, received from Royal Observatory, 1866.

Five bronze line yards, Nos. 12, 30, 41, 42, 44.

One line yard of cast brass, No. 46, 1844.

Brass tubular bar, No. 50.

Line yard, No. 52, of Maudslay's copper.

Line yard, No. 53, 1845, of May's mixture.

Three cast steel line yards, A, B, C.

Glass yard.

Swedish iron yard, No. 70.

Bronze end standard yards, Nos. 45 and 69.

Cast-iron yards, A No. 61, B No. 62, C No. 63.

Bronze end measures, foot No. 76, foot No. 77, six-inch No. 79, six-inch No. 80, three-inch No. 81, three-inch No. 82.

Six-inch line measure, marked on gold studs in a brass bar, constructed for use in India.

Ramsden's 20 feet standard.

Ten-feet standard, used for measuring an arc of the meridian at the Cape of Good Hope.

Ten-feet standard, used for measuring an arc of the meridian in India.

Standard yard, 1869, denoted as S.S., subdivided into feet, and one foot into inches, with four additional inches and further subdivisions. This is a line standard measure, marked on gold studs on a bronze bar of Baily's metal, upon which a metre with its subdivisions is also marked.

A standard inch measure, marked on a slip of silver inserted in a small bronze bar; divided into tenths and one-tenth into hundredths of an inch.

2. Weights:—

The Imperial Standard pound, marked "PS. 1844;" made of platinum, of cylindrical form with a groove.

Troy pound of platinum, marked "T."

Twenty-six auxiliary weights of platinum, marked respectively A, B, C, D, F + G (each 1,240 grains), F (800 gr.), G (440 gr.), H (360 gr.), K, L, M, N (each 80 gr.), R, S (each 40 gr.), W (12·901 gr.), V (6·451 gr.), with ten of Q (each 0·64509 gr., being the difference, *when weighed in ordinary air*, of the Imperial standard pound of platinum, and the commercial standard pound of brass, each weighing 7,000 grains in a vacuum). These auxiliary platinum weights were used, together with T, by Professor W. H. Miller in the restoration of the Imperial standard pound.

Four gilt gun-metal weights of 1 lb. avoirdupois each, marked respectively Nos. 31, 32, 33, 34, verified by Professor Miller, 1855.

A pound weight of quartz Q, verified with the Imperial Standard pound by Professor W. H. Miller in 1846.

A brass weight of 10 lbs., denoted as K; being the weight of a gallon of water, verified by Captain H. Kater, 1824, and used by him for the determination of the imperial standard gallon.

A gilt gun-metal weight of 10 lbs., denoted as M, verified by Professor Miller, 1855.

A series of nine auxiliary bronze weights, viz., 12,800, 6,400, 3,200, 1,600, 800, 400, 200, and two of 100 grains, used by Professor Miller in his observations during the construction of the new imperial standard pound.

A series of 21 decimal grain standard weights of gilt gun metal; viz., 1,000, 500, 300, 200, 100, 50, 30, 20, 10, 5, 3, 2, 1, 0·5, 0·3, 0·2, 0·1, 0·05, 0·03, 0·02, 0·01 grain; officially verified 1870.

Appendix XVIII.—*continued.*

2. Weights—*cont.*

Four decimal grain weights of gilt gun metal, marked respectively 4,000, 2,000, 1,000B, 500B grains.

Two weights of ⅓ and ⅔ oz. each, for foreign postal services, officially verified 1870.

A series of 16 standard coin weights, constructed in pursuance of the Coinage Act, 1870, and including the following :—

——		Imperial Weight.	Metric Weight.
Gold coin weights :			
Full weight :		grains.	grammes.
Five sovereigns - -	of gilt gun-metal	616·37239	39·94028
Two sovereigns - -		246·54895	15·97611
Sovereign - - -	of standard gold	123·27447	7·98805
Half-sovereign - -		61·63723	3·99402
Least weight :			
Five sovereigns - -	of gilt gun-metal	612·50000	39·68935
Two sovereigns - -		245·00000	15·87574
Sovereign - - -	of standard gold	122·50000	7·93787
Half-sovereign - -		61·12500	3·96083
Silver coin weights :			
Crown - - - -	of an alloy of palladium and silver	436·36363	28·27590
Half-crown - -		218·18181	14·13795
Florin - - - -		174·54545	11·31036
Shilling - - -		87·27272	5·65518
Sixpence - - -		43·63636	2·82759
Groat, or 4*d*. - -		29·09090	1·88506
Threepence - -		21·81818	1·41379
Twopence - - -		14·54545	0·94253
Penny - - - -		7·27272	0·47126
Bronze coin weights :			
Penny - - - -	of bronze - -	145·83333	9·44984
Half-penny - -		87·50000	5·66990
Farthing - - -		43·75000	2·83495

Measures of capacity :—

Imperial standard bushel, 1824, with mahogany stand and cover.

Two conical measures of the imperial gallon, Nos. 1 & 2.
Two ,, ,, ,, ,, quart ,,
Two ,, ,, ,, ,, pint ,,

These are made of gun metal, and were verified by Captain Kater in 1824.

IV. Auxiliary standards.

IV.—*Auxiliary Standards, used in the verification of Standards of legal denominations.*

1. Measures of length :—

Brass slider, denoted as S, having the measure of a foot, and a decimetre, with subdivisions, marked on it; used in the verification of subdivided standard measures.

2. Weights :—

A weight of a gallon of water, 10 lbs., denoted as O, made of Baily's metal; officially verified 1869.

Fourteen weights of 1 lb. avoirdupois each, of bronze, Nos. 35–48; officially verified 1869, and used in the verification of standard weights which are multiples of 1 lb.

Five grain weights of gilt gun metal, viz., 600, 60, 6, 0·6, 0·06, and five bronze grain weights, distinguished as No. 1, viz., 600, 60, 6, 0·6, 0·06 grains; officially verified 1869.

A box of "balance weights," containing numerous verified small weights of platinum and aluminium; used in the determination of the value of one division of the balance index.

Three weights of 62·321 lbs. each, or the weight of a cubic foot of water, made of gun metal, and verified in 1859, and re-adjusted and reverified in 1869. Of these one is the standard, with copies Nos. 1 and 2 respectively. A third copy, No. 3, is to be presented to the French Government.

3. Measures of capacity :—

A standard gallon of gun metal, constructed by Messrs. Tylor 1870. (See also List of Apparatus.)

4. Gas-measuring standards :—

Standard cubic foot transferrer and standard cubic foot bottle, No. 1, verified by the Astronomer Royal 1859.

Three cubic foot transferrers, officially verified 1860.

V. Official standards now in use.

V.—*Official Standards, or legal Secondary Standards, for verifying Copies to be used by local Inspectors of Weights and Measures, &c. (exclusive of Troy and Bullion Standard Weights included in* II.).

1. Measures of length :—

Commercial standard yard, 1870, denoted as C.S., subdivided into feet and inches, and twentieths of an inch, with Vernier scale, showing any difference to 0·001 inch. This is a solid bar of Baily's metal, mounted on a comparing apparatus (see also Paper XXXII.), and is now used as the official standard yard.

A massive ten-feet steel bed, subdivided into feet, one foot into inches, and one inch into eighths of an inch; together with two ten-feet steel bars, terminating in plane edges at right angles to each other. These are all supported on strong wooden frames.

A massive six-feet steel bed, subdivided into feet, one foot into inches, and one inch into eighths; with two similar six-feet steel rods.

A three-feet flat brass scale, No. 48, with subdivisions to 0·1 inch, received from the Royal Observatory in 1866.

Note. Measures of the chains of 100 feet and of 66 feet, divided into tenths, and hundredths, or links, are to be laid down as public standards.

2. Weights :—

A set of 16 avoirdupois standard weights, with their counterpoises, all of brass, made and verified in 1824, and used until 1870 as working official avoirdupois standards, viz., 56, 28, 14, 7, 4, 2, 1 lb.; 8, 4, 2, 1 oz.; 8, 4, 2, 1, ½ dm. These weights were re-adjusted and officially verified in 1870, and are now kept as official standards of reference.

A similar set of 16 avoirdupois standard weights, from 56 lbs. to ½ dram, constructed of Baily's metal, and officially verified in 1869; now used as the working official standard avoirdupois weights.

Three sets of decimal grain weights, from 1,000 to 0·01 grain, denoted as Nos. 1, 2, and 3 respectively; the larger weights being of gun metal and smaller weights of platinum or aluminium.

Four decimal grain weights of 4,000, 2,000, 1,000, 500 grains, made of bronze, and distinguished as No. 1.

Three sets of bronze weights of ⅓ and ⅔ oz. for foreign postal services, officially verified 1870.

A series of 16 coin weights constructed in pursuance of the Coinage Act, 1870, as specified under III.; officially verified 1870.

A set of 8 glass weights, from 7 lb. to 1 oz., made by Mr. Oertling and Messrs. Chance, 1870.

3. Measures of capacity :—

A set of 10 imperial measures of gun metal, and cylindrical in shape, viz., bushel, half bushel, peck, gallon, half gallon, quart, pint, half pint, gill, half gill, supplied to the Exchequer in 1834, and then officially verified, and since reverified in 1870.

An additional set of six measures constructed and verified in 1870, viz., ⅙ gallon and $\frac{1}{12}$ gallon, or the standard bottle and half bottle, 4, 2, 1, ½ fluid oz.

Two sets of 16 glass burettes, being measures of grains weight of distilled water, constructed and officially verified in 1870, viz., 7,000, 4,000, 2,000, 1,000, 500, 300, 200, 100, 50, 30, 20, 10, 5, 3, 2, 1 grains.

Two sets of seven glass burettes of cubic inch measures, viz., 10, 5, 2, 1, 0·5, 0·2, 0·1 cubic inch.

4. Gas measurers :—

Three gasholders of 10 cubic feet, 5 cubic feet, and 1 cubic foot respectively, originally verified by the Astronomer Royal in 1860, and officially reverified in 1870.

Two standard cubic foot bottles, Nos. 2, 3, officially verified 1860, and reverified 1870.

Four test gas meters for testing local standards to be used in verifying commercial meters in situ, viz., two wet meters passing five cubic feet and one cubic foot respectively at one revolution, and two dry meters passing 2·5 and 0·5 cubic feet respectively at one complete action.

METRIC SYSTEM.

VI.—*Standards of a Primary Character.*

VI. Met standard a primar characte

1. Measures of length :—

Line standard metre, 1867, marked on gold studs upon the bronze bar S.S., subdivided into decimetres, centimetres, and millimetres; officially verified in 1870, with the two platinum metres of the Royal Society.

Gilt steel-end metre, 1870, having ends of osmium-iridium.

A brass metre à bouts, 𝔐𝔅.

Appendix XVIII.—*continued.*

1. Measures of length—*cont.*

A brass metre à traits, 𝕸𝕿.

These two metres were verified at the Conservatoire Impérial des Arts et Métiers at Paris, and presented by the French Government.

2. Weights:—

Platinum kilogram 𝕰, verified by Professor Miller, 1844, by comparison with the Kilogramme des Archives, Paris.

Gilt brass kilogramme, 𝕶𝕭, cylindrical with a knob.

Gilt brass kilogramme, 𝕶𝕮, cylindrical, of equal diameter and height.

These two kilograms were verified at the Conservatoire Impérial des Arts et Métiers at Paris, and presented by the French Government.

A kilogram of quartz, constructed and verified by Dr. von Steinheil, at Munich.

3. Measures of capacity:—

Standard brass litre, also verified at the Conservatoire des Arts et Métiers at Paris in 1869, and presented by the French Government.

VII.—*Official Metric Standards for verifying Copies to be used by Local Inspectors of Weights and Measures, &c.*

VII. Official metric standards.

1. Measures of length:—

Commercial standard metre, marked on the bronze bar C.S., 1869, subdivided into decimetres, centimetres, and millimetres, with vernier scale, showing differences of 0·02 mm.

Flat brass scale of one metre in length subdivided into decimetres, centimetres, and millimetres, made by Deleuil, of Paris, and purchased from Messrs. Tylor, 1869.

A subdivided brass standard metre, presented by the French Government, 1870.

Note. The metric chain of a double dekametre, or 20 metres, divided into dekametre, demi-dekametre, double metre, and metre, is to be laid down as one of the public standards of length. Messrs. Troughton and Simms, 1870.

Bronze copies of an end metre, half metre, double decimetre, decimetre, and centimetre, are also to be exhibited as public standards.

A glass metre is being constructed for the Standards Department, by Dr. von Steinheil, of Munich.

A flat brass subdivided metre à bouts, marked "Gambey à Paris. Metre."

2. Weights:—

A gilt gun-metal kilogram 𝕶, verified by Professor Miller, 1853.

A series of 10 brass weights, viz., a kilogram, cylindrical with a knob, and nine rectangular brass weights; 500 grain to 1 gr. respectively, denoted as 𝕸: received from the Royal Mint, 1868, having been made by Fortin, Paris, in 1824, and verified for and presented to the British Government.

A set of 14 brass weights, cylindrical with a knob, denoted as 𝕿, viz., 20, 10, 5, 2, 1 kilo., 500, 200, 100, 50, 20, 10, 5, 2, 1 gram.; made by Deleuil, Paris, and purchased from Messrs. Tylor, 1869; officially verified 1870.

Three sets of small metric weights, of platinum, 14 in number, viz., 5, 2, and duplicates of 1, decigram; 5, 2, and duplicates of ·1, centigram; 5, 2, and duplicates of 1, milligram; and duplicates of 0·5 milligram. These are made by Deleuil, and were officially verified in 1870, being denoted as series 𝕬, 𝕭, and 𝕮 respectively.

A series of 10 bronze weights of one kilogram each, denoted as $\mathfrak{K}^{1}$ to $\mathfrak{K}^{10}$, and used in the verification of weights which are multiples of one kilogram; made by Oertling, and officially verified in 1870.

Five flat weights of 100, 50, 20, 10, 10 grammes, respectively, of bronze, made by Messrs. De Grave and Co., 1870, and intended as postal weights.

Nine cylindrical weights, with a groove, 1,000 to 10 grammes, of bronze, made by Messrs. De Grave and Co., 1870, and intended as postal weights.

A series of standard brass weights, five in number, viz., 20, 10, 5, 2, 1 kilogram, presented by the French Government, 1870.

Two sets of metric weights, 1,000 to 1 gram. of opaque glass, adjusted with mercury and hermetically sealed; made by Salleron, Paris, 1869, of the density of brass weights, and officially verified in 1870.

2. Weights—*cont.*

A series of brass weights, 500 to 0·005 gram., cylindrical with a knob, obtained from and officially verified by the Standards Commission, Berlin; used as postal weights of the North German Confederation.

3. Measures of capacity:—

A series of 11 brass cylindrical measures, made by Deleuil, officially verified in 1870, viz., double dekalitre, dekalitre, demi-dekalitre, double litre, litre, demi-litre, double decilitre, decilitre, demi-decilitre, double centilitre, centilitre.

A similar series of 11 standard brass measures of capacity, double dekalitre to centilitre, presented by the French Government, 1870.

A series in duplicate of 10 glass burette measures made by Messrs. Griffin, and officially verified 1870, viz., litre or 1,000 cubic centimetres, 500 c. c., 200 c. c., 100 c. c., 50 c. c., 20 c. c., 10 c. c., 5 c. c., 2 c. c., 1 c. c.

A necessaire de Verificateur, presented by the French Government, containing the following standards, such as are used by the local verifiers in France:

A subdivided metre and decimetre.

A brass kilogram and smaller weights.

A steelyard, with weight, to test above a kilogram.

A gauge for testing measures of capacity.

Together with other instruments of verification.

VIII.—*Standards of other Countries, exclusive of Metric Standards already described.*

VIII. Standards of other countries, exclusive of metric standards.

A collection of the standards of the United States of North America, duly verified and presented by the U. S. Government in 1842, and contained in mahogany boxes, viz.:—

Ten solid brass avoirdupois weights, marked with an eagle, viz.: 50, 25, 20, 10, 5, 4, 3, 2, 1, $\frac{1}{2}$ lb. avoirdupois.

Twenty-eight brass troy weights, viz.: 1 lb., 10, 6, 5, 4, 3, 2, 1, 0·5, 0·4, 0·3, 0·2, 0·1, 0·05, 0·04, 0·03, 0·02, 0·01, 0·005, 0·004, 0·003, 0·002, 0·001, 0·0005, 0·0004, 0·0003, 0·0002, 0·0001 oz.

Brass yard, consisting of a bed, and its matrix or end standard.

Six brass cylindrical measures of capacity, viz., $\frac{1}{2}$-bushel, gallon, $\frac{1}{2}$-gallon, quart ($\frac{1}{4}$-gallon), pint ($\frac{1}{8}$-gallon), $\frac{1}{2}$-pint ($\frac{1}{16}$-gallon).

A collection of standard commercial and money weights received from the Royal Mint, 1868, collected in 1818, by the British Government, at the instance of Dr. Kelly, from the following countries, and duly verified, viz.:—

Alicante, Amsterdam, Ancona, Antwerp, Bahia, Balearic Isles, Barcelona, Bordeaux, Boston, Bremen, Cape of Good Hope, Carthagena, Charente, Civita Vecchia, Constantinople, Corunna, Dantzic, Elsinore, France, Genoa, Gothenburg, Hamburg, Havre, Leghorn, Libau, Lisbon, Lubec, Madeira, Madrid, Malaga, Maranham, Minorca, Nantes, New York, Nice, Oldenburg, Ostend, Paris, St. Petersburg, Philadelphia, Riga, Revel, Rio Janeiro, Rome, Rotterdam, Smyrna, Stettin, Stockholm, Trieste, Tripoli, Tunis, Valentia, Venice.

These are arranged in the drawers of a mahogany cabinet.

A box of Jersey standard cup weights of the following denominations; 1 livre, 4, 2, 1 once, 4, 2, 1 gros, 1 demigros, received from the Royal Observatory, 1866.

A series of old French cup weights of latten, weighing together 8 lbs. of the old Poids de Marc of Rouen; presented by Colonel Le Couteur, Viscount of Jersey.

IX.—*Specimens of Commercial Weights and Measures, &c.*

IX. Specimens of commercial weights and measures.

Measures of length:—

Various unfinished bars of gun metal, brass, steel, copper, &c., provided for the Committee for restoring the standards, and intended for yard, foot, &c. standards.

A series of eleven draughtsman's boxwood scales, Imperial measures, made by Elliot and Sons.

Two boxwood yards, subdivided into inches and quarter inches; and tipped with brass.

A 10-feet levelling staff used by surveyors.

Two surveyors' chains of 100 feet and of 66 feet, divided into links.

A bootmaker's wooden gauge, subdivided into inches and thirds of an inch, or barleycorns.

Appendix XVIII.—*continued.*

Measures of length—*cont.*

- Chesterman's patent ribbon steel metre and yard, with subdivisions.
- A flat wooden school metre, with subdivisions of the metre and yard, published by the International Decimal Association, and presented by James Yates, Esq.
- A folding boxwood metre, by Elliot and Sons, presented by James Yates, Esq.
- A 12-inch calliper measure of steel, with subdivisions and vernier to 0·001 inch, made by Messrs. Browne and Sharp, Rhode Island, U.S.
- A circular spring gauge, from 0·1 to 0·001 inch, made by J. Cocker.
- Various two-foot and one-foot measures.

Weights, &c.:—

- A 56 lb. japanned iron brick weight, proposed for testing weighbridges, presented by Messrs. Pooley and Sons, Manchester.
- A 14 lb. iron brick weight, by Day and Son.
- A series of square japanned iron weights, with rings, from 56 lb. to 1 lb., and 5 kilo. to 1 kilo.
- A series of flat iron weights, 4 lb. to 1 oz.
- A series of round flat brass metric weights, 1,000 to 1 gram.
- A series of eight patent glass weights of various colours, spherical shape, and adjusted with lead, made by Dowling.
- A 1-lb. and ½-lb. enamelled iron weight.
- Various glass coin weights of one sovereign and half sovereign.
- Two grooved cylindrical brass weights of 500 grammes, made by De Grave and Co., as specimens of distinctive metric weights.
- Two Russian iron weights, spherical shape, presented by J. Yates, Esq.
- A circular spring balance, graduated to weigh up to 30 lb., by Salter.
- A circular spring steelyard, to weigh up to 14 lb., by Salter.
- A French equipoising scale for counter use, to weigh up to 1 kilogram.

Weights, &c.—*cont.*

- A French balance bascule, to weigh up to 500 kilo., made at Lyons, and procured through Messrs. Nichol and Fowler.
- Two ordinary shop counter balances, with enamelled pans, one of proper construction, the other cheaply made and defective.

Measures of capacity:—

- Two glass pint tankards, with inspector's stamp affixed to the handle, presented by Mr. W. Gregg, Inspector, West Middlesex.
- A set of Richardson's patent stamped glass measures, consisting of six decanters, ½-pint to ¼-gill, and five pint and half-pint tankards and tumblers, presented by J. Couper and Sons, Glasgow.
- Four glass flask measures of 1 litre, 1 pint, ½ pint, and ¼ pint, made by Griffin and Sons.
- A series of Apothecaries graduated glass jars, to contain from 10,000 grains weight of water, and 600 cubic centimetres downwards, made by Griffin and Sons.
- Models in wood of the double litre, litre, decilitre, and cubic decilitre, published by the International Decimal Association, and presented by J. Yates, Esq.

Other measures, &c.:—

- Two 3-light gas meters, one wet and one dry, with glass sides and top, for inspection of the mechanism and action of gas meters, by Wright and Co.
- Various specimens of fraudulent weights and measures, seized and presented by Inspectors of Weights and Measures.
- A complete collection of the legal metric weights and measures, and of balances and apparatus furnished to each Bureau de Verification in France, presented by the French Government.

H. W. CHISHOLM,
Warden.

Standards Department,
30th July 1870.

APPENDIX XIX.

Paper delivered by the Warden of the Standards. — List of Balances and other Comparing or Auxiliary Apparatus of the Standards Department.

Contents.

Page
I.—List of apparatus used in the comparison of measures of length - - - - - - 226
II.—List of balances and other apparatus for the comparison of weights - - - - - 227
III.—List of apparatus used in the comparison of measures of capacity - - - - - „
IV.—List of apparatus used in the comparison of gas-measuring standards - - - - - 228
V.—List of thermometers, barometers, hydrometers, &c. - „
VI.—List of official stamps and stamping or marking apparatus of the Standards Department - - „

I.—*List of Apparatus used in the Comparison of Measures of Length.*

(1.) The elaborate microscopic comparing apparatus which was constructed for and used by Mr. Sheepshanks in his numerous observations for the restoration of the Imperial yard and its copies, between 1844 and 1853, having been placed in the basement of the rooms in Somerset House occupied by the Astronomical Society, was transferred in 1868 to the strong room of the Standards Department, and put into complete order for use. A description and drawings of this comparing apparatus may be found in the Astronomer Royal's account of the construction of the new Imperial standard yard. A third microscope has recently been added, and the apparatus is now available for the comparison of both yard and foot measures.

In connexion with this microscopic apparatus, is a gun-metal plane, with measuring and dividing apparatus, and an apparatus for grinding the spherical ends of bars; also used in the construction of the Imperial yard and its several copies.

(2.) An apparatus consisting of a micrometer screw, and gun-metal bed, and V supports, for approximate comparisons of standard end measures; also constructed for Mr. Sheepshanks.

(3.) A vertical comparing apparatus for determining differences in end standard yards by means of contact points and a graduated spirit level; deposited in the Department in the year 1857.

(4.) The new and improved apparatus, fitted with five microscopes and micrometers, constructed in 1866, for comparing standard measures of length from 20 feet to 0·01 inch, and provided with traversing carriage on iron rails for the support of the standards under comparison, is placed in the arched room on the first floor of the Tower. It is furnished with a smaller apparatus fitted with rectangular steel and spherical gun-metal contact pieces, for the comparison of both end and line measures. This apparatus is described and a drawing of it given in Paper XIX.–I. (App. VII. to Fifth Report).

(5.) The comparing apparatus attached to the new commercial standard of length, for verifying local standards and other measures of Imperial and Metric length; constructed in 1870. Also described in Paper XIX.–I., where a drawing of the apparatus is shown.

(6.) A micrometric apparatus for the external measurement by contact of cylindrical and other bodies, and provided with levelling and supporting adjuncts; recently designed by Professor Miller.

(7.) Micrometer apparatus and callipers for internal

Appendix XIX.—*continued.*

measurement of standard measures of capacity, used in the determination of capacities by linear measurement.

(8.) An apparatus for determining the expansion of metallic bars at various temperatures, from melting point of ice to the boiling point of water.

(9.) An improved cathetometer for reading vertical graduations, &c., and furnished with both Imperial and Metric scales.

[All the apparatus, numbered 1 to 9, was constructed by Messrs. Troughton and Simms.]

(10.) Two steeled-backed squares, by Holtzapffel, used in testing local standard yard beds.

(11.) A universal square, of steel, by Browne and Sharpe, of Providence, Rhode Island, United States.

(12.) A steel subdivided scale of 18 inches, with vernier and callipers; and a smaller similar subdivided steel scale of 6 inches; also made by Messrs. Browne and Sharpe.

(13.) Small test glass used with micrometer microscopes, having minute subdivisions of the millimetre cut on it; known as Nobert's lines.

(14.) Two patent candle lamps and two sperm oil lamps, with telescopic stands; used in illuminating the defining lines of standard measures, when compared under the microscopes.

(15.) Three accurately planed brass bars, 40 inches long and 1 inch broad, and two similar bars of Baily's metal, used occasionally as supports for measuring bars on the comparing apparatus.

(16.) Several spare sets of lever frames and parallel rests used in supporting bars.

(17.) Thick woollen rugs used in maintaining uniform temperature of bars under comparison.

II.—*List of Balances and other Apparatus for the Comparison of Standard Weights.*

(18–21.) A set of four balances with steel beams and box ends, constructed in 1825, by Messrs. De Grave and Co., and used until 1870 for the comparison of local standard weights, viz. :—

Balance (A) to weigh from 56 lbs. to 14 lbs., to turn with an additional load of 3 grains.
„ (B) to weigh from 7 lbs. to 2 lbs., to turn with 1 grain.
„ (C) to weigh from 1 lb. to 1 oz., to turn with 0·1 grain.
„ (D) to weigh from 1 oz. to 1 grain, to turn with 0·05 grain.

(22–25.) A set of four new balances with beams of bronze (Baily's metal), having steel knife-edges with agate bearings, and all the modern improvements, made by Messrs. De Grave and Co., 1870, for the comparison of local standard weights, and to be substituted for the old balances, viz. :—

Balance (E) to weigh 56 lbs. to 14 lbs., to turn with 1 grain.
„ (F) to weigh 7 lbs. to 2 lbs., to turn with 0·5 grain.
„ (G) to weigh 1 lb. to 1 oz., to turn with 0·05 grain.
„ (H) to weigh 1 oz. to 1 grain, to turn with 0·01 grain.

(26–31.) A set of six balances of the best construction, each with gun-metal beams, steel knife-edges, and agate planes, for comparing primary standard weights, as well as measures of capacity by the weight of distilled water contained in them; (No. 1 to 4 made by Messrs. Ladd and Oertling, and No. 5 and 6 by Mr. Oertling,) viz. :—

No. 1. to weigh 56 lbs. to 14 lbs., to turn with 0·2 grain.
No. 2. to weigh 10 lbs. to 7 lbs., to turn with 0·05 grain.
No. 3. to weigh 1 lb. to 2 ozs., to turn with 0·01 grain.
No. 4. to weigh 1 oz. to 1 grain, to turn with 0·005 grain.
No. 5. to weigh 1 kilogram or 2 kilog., to turn with 0·001 grain, 0·01 grain, or 0·6 milligram.
No. 6. to weigh 30 grains to 0·01 grain, to turn with 0·0002 grain.

(32.) A balance to weigh a standard pound or kilogram in each pan, made by Barrow, to turn with 0·01 grain when loaded, fitted with two microscopes for reading the Index scales, and used by Professor Miller in his numerous observations for the restoration of the Imperial pound and its copies; with a mahogany case in which it can be packed for travelling.

(33.) Capt. Kater's large balance with mahogany beam, for weighing a standard bushel, and the larger measures of capacity, when filled with water; to turn with a grain with 300 lbs. in each pan. Made by Mr. Bate, 1825, and re-constructed by Messrs. Ladd and Oertling in 1867.

(34.) Professor Hassler's balance, to turn with 4 grains with 56 lbs. in each pan, with brass beam and steel supporting pivots and bearings, to weigh from 56 lbs. to 7 lbs.; presented by the American Government in 1843.

Each of these balances (No. 18 to 33) stands in a plate glass case upon a firm support.

(35.) A vacuum balance for comparison of standard weights up to 1 kilogram, now being constructed by Mr. Oertling. The whole balance is placed in an air-tight case, from which the air can as far as possible be exhausted; the pressure of the rarefied air being measured by a manometer connected with the balance case. There are contrivances, suggested by Professor Miller, for changing the weights and pans, without opening the case or disturbing the vacuum.

(36.) A large air pump used in connexion with the vacuum balance; constructed by Messrs. Troughton and Simms.

(37.) Three telescopes, with adjusting stands, for reading indices of balances at a convenient distance.

(38.) Three electro-plated reflectors on stands, for illuminating indices of balances.

(39.) Three plate glass screens in mahogany frames, used in protecting balances from draughts, &c.

(40.) Reels of fine silver-gilt, copper, and aluminium wire, for the construction of small balance weights for Departmental use.

(41.) Spirit lamp, gas lamp, and glass beakers, jars, and porcelain saucers, used in determination of density of weights by weighing in boiled water.

(42.) Stereometer, for ascertaining the density of standard weights, and other substances which may not be weighed in water.

(43.) Gun-metal and glass cubes, for determining the weight of a cubic foot, or other volume of water, now being constructed by Messrs. Troughton and Simms.

(44.) Various pincers and instruments of steel, brass, ivory, and hard wood, for lifting standard weights.

III.—*List of Apparatus used in the Comparison of Measures of Capacity.*

(45.) Lifting apparatus, stand, rack, and lever, for comparison of standard bushels, constructed by Messrs. De Grave, 1867.

(46.) A copper still, lined with tin, and gas furnace, together with pure tin pipes, worm, and cistern, for distilling and holding distilled water; constructed by Messrs. Tylor, 1869.

(47.) Improved cubic foot apparatus, made by Mr. Sugg, to be used in the verification of cubic foot measures, and available also for other measures of capacity.

(48.) Standard gallon measure and transferring apparatus of gun metal, constructed by Messrs. Tylor, and capable of being fitted with means for determining approximate specific gravities.

(49.) Burette stand and transferring apparatus, for comparing burettes and graduated glass tubes, made by Messrs. Griffin, 1870.

(50.) Glass reflector mounted on tripod stand, two mahogany levelling stools, small iron stand with thumb screws and rings of various sizes, and several wooden stands for holding burettes; used with burette stand.

(51.) Series of glass funnels of various shapes and sizes, made by Messrs. Griffin, used in filling burettes and measures of capacity.

(52.) Four glass syphons with brass cocks, made by Mr. Bate; 12 glass syphons, and two large bent copper funnels, made by Messrs. De Grave, used for a similar purpose.

(53.) Various chemical solutions used in testing distilled water, with test tubes, evaporating dishes, &c.

(54.) Nineteen graduated glass tubes, and twelve pipettes, graduated into cubic inches, fluid ounces, and cubic centimetres, and grains weight of distilled water, used in the comparison of local standard measures of capacity.

(55.) Twenty-four half-gallon glass bottles (Winchesters), 2-gallon glass jars with stop-cocks, and a 65-litre earthenware moveable cistern, with glass gauge, &c.; for holding distilled water.

(56.) The Astronomer Royal's wooden gauge for measures of capacity; designed for the use of inspectors as a ready and approximative test of the contents of measures in markets and open places.

(57.) A brass copy of the Astronomer Royal's gauge, made by Messrs. Vandome, Titfords, and Pawson.

(58.) A folding copy of the above gauge in box wood, made by Messrs. De Grave and Co.

(59.) Four comptes gouttes, made by Salleron, for the accurate determination of the weight of drops of various liquids.

Appendix XIX.—*continued.*

(60.) Small micrometer apparatus and callipers for internal measurement of cubical or cylindrical standard measures of capacity, and for determining capacities by linear measurement.

(61.) Apparatus with levelling screws for determining the plane or surface level of the water contained in the bushel and large standard measures of capacity.

Note.—In the determination of the contents of primary standard measures of capacity, the balances referred to in the list of weighing apparatus, particularly Capt. Kater's large balance, are used, it being necessary to determine the weight of water, as well as the cubical contents of such measures.

IV.—*List of Apparatus used in the Comparison of Gas-measuring Standards.*

(62.) Cubic foot apparatus designed by Mr. Geo. Glover, for filling the standard cubic foot with water, and used in the verification and re-verification of the official gas measuring standards.

(63.) Improved cubic foot apparatus, made for a similar purpose by Mr. W. Sugg, to be used in the verification of cubic foot measures.

(64.) Level tables, connected with the gas measuring standards; upon which are mounted pressure gauges, thermometer stands, and the outlet and inlet pipes of the several standards.

(65.) Astronomical clock beating dead seconds, for determining rate of speed of gas or air passing through measuring standards; made by Pennington, London.

(66.) Four King's pressure gauges, made by Messrs. Wright and Co., used in the comparison of gas measurers.

(67.) Air condensing apparatus, for cleaning interior of pipes.

(68.) Three standard cubic foot transferrers, made by Messrs. Crosley and Co., and a cubic foot transferrer made by Mr. King, C.E.

(69.) Several tin funnels used in filling gas measurers, plummet and spirit levels, and various tools for connecting and adjusting gas measurers.

(70.) Two boxwood scales and slides, made by Salleron, Paris, to be used as gauges for readily correcting volumes of gas for expansion by heat and pressure.

(71.) A 3-litre glass sphere, with brass stop-cock, for determining the specific gravity of gases; made by Deleuil, Paris.

V.—*List of Thermometers, Barometers, Hydrometers, &c.*

(72.) Two thermometers, 32°–92° Fahr., used together as a psychrometer, No. 1 and 2. Troughton and Simms, 1865.

(73.) A Sikes' self-registering maximum and minimum thermometer, 1866.

(74.) Eight minimum and maximum thermometers, 32°–92° Fahr. Nos. 3781, 3782, 3783, 3784, 8477, 8493, 8502, 8505. Negretti and Zambra, 1867.

(75.) Two standard thermometers, 32°–212° Fahr. Nos. 428 and 430. Presented in 1868 by the Committee of Kew Observatory.

(76.) Four standard thermometers. Troughton and Simms, Nos. 1, 2, 3, 1868; No. 4, 1870.

No. 1 - - 50°–60° Fahr. No. 3 - - 60°–70° Fahr.
„ 2 - - 60°–70° „ „ 4 - - 50°–60° „

(77.) Two thermometers, made by Salleron of Paris, 0°–100° C. Nos. 4935, 4937, 1869.

(78.) Three thermometers, 0°–30° C., used with gas measuring standards, Nos. 12912, 12913, 12914. Negretti and Zambra, 1870.

(79.) Nine thermometers, 32°–92° Fahr. Nos. 5, 6, 7, 8, 12, 13, 15, 16, 61. Constructed for gas measuring standards. Negretti and Zambra, 1868–1870.

(80.) Three standard thermometers, 30°–90° Fahr. Nos. 12763, 12764, 12765. Negretti and Zambra, 1870.

(81.) Two thermometers, 32°–92° Fahr., constructed to be used with Cape of Good Hope 10-ft. standard, No. 3 and 4. Troughton and Simms.

(82.) Three barometer thermometers, 50°–70° Fahr. Nos. 12321, 12322, and 12909. Negretti and Zambra.

(83.) Three standard barometers, with brass scale subdivided into inches and decimal parts, and with vernier, having attached tubes containing mercury for insertion of thermometers; Nos. 417 (1860); 690, 691 (1866). Negretti and Zambra.

(84.) A Regnault's condenser hygrometer, for ascertaining the amount of vapour present in gas or air, made by Deleuil of Paris, 1870; with simple aspirator, and sulphuric ether for use with the condenser.

(85.) Bate's gilt saccharometer, with thermometer and adjusting.

(86.) Sikes' gilt hydrometer with adjusting weights.

(87.) United States standard hydrometer, consisting of five glass hydrometers bearing the stamp of the Standards Office at Washington, with thermometer, &c.; presented by the American Government, 1870.

(88.) Apparatus for testing petroleum under the Petroleum Act, 1868, by determining the flashing point of the vapour given off light essential oils.

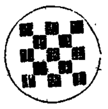
(89.) Improved apparatus for testing petroleum according to the open and close test, suggested by Mr. Mills, Inspector of Petroleum, Western Middlesex.

VI.—*List of Official Stamps and Stamping or Marking Apparatus of the Standards Department.*

(90.) A hand press and die for impressing the official seal on the indentures of verification.

(91.) Two sets of steel dies GR. IV. Crown., and one set WR. Crown., formerly used for stamping standards.

(92.) Two sets of steel dies VR. Crown. now used in stamping local standard weights and measures.

(93.) Two sets of steel dies  used until 1870 in impressing the "chequers" or Exchequer seal on local standards.

(94.) Sixty-nine copies of stamps to be supplied to Inspectors of Gas Meters under the Sale of Gas Act, 1859.

(95.) Five moulds and two seals, for affixing fusible metal stamp on gas-measuring standards.

(96.) Press and die used in sealing cubic foot bottles.

(97.) Press and dies for stamping coin weights, in pursuance of Coinage Act, 1870.

(98.) Set of dies for numbering in block figures the local standard weights and measures.

(99.) Revolving drill apparatus for engraving official marks of verification on standard measures.

H. W. CHISHOLM,
Warden.

Standards Office,
30th July 1870.

APPENDIX XX.

PAPERS DELIVERED by the WARDEN OF THE STANDARDS. VERIFICATION of NEW IMPERIAL STANDARD MEASURES of 10 FEET and 6 FEET ; of ADDITIONAL NEW STANDARD WEIGHTS ; and of STANDARD TEST GAS METERS.

Page
PART 1.—VERIFICATION of 10-FEET and 6-FEET STANDARD BARS - 229
PART 2.— „ NEW GLASS STANDARD WEIGHTS - - 234
PART 3.— „ NEW STANDARD COIN WEIGHTS - - 248
PART 4.— „ NEW STANDARD TEST GAS METERS - - 255

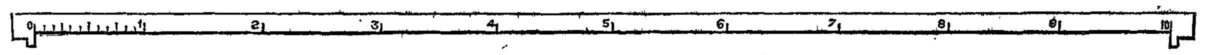
PART 1.—VERIFICATION of 10-FEET and 6-FEET STANDARD BARS.

CONTENTS.

Page
Description of these new standards of length - - - 229
Mode of comparison - - - - - - - „
Comparisons of 10-feet line standard measure - - - „
„ each foot on 10-feet standard bar - - 230
„ 10-feet line standard with East Indian 10-feet standard - - - - - 231
„ two standard 10-feet end bars, Nos. 1 and 2 „
Comparison of 6-feet line standard measure - - - 232
The Astronomer Royal's method of comparing end measures with line measures - - - - - - - - 232
Verification of standard 6-feet end bar by this method - 233
All these bars now sufficiently verified as commercial standards 234
10-feet bed to be marked with defining lines on platinum studs in sunk wells - - - - - - - - „
And second carriage, with the requisite supporting rollers, to be furnished - - - - - - - - „

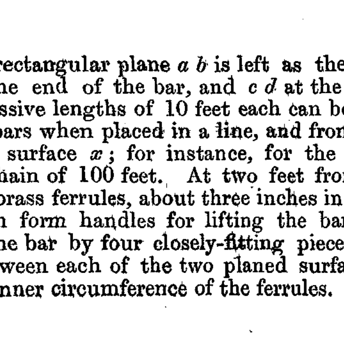
Description of these new standards of length.

The Standard measure of 10 feet consists of a steel bed of the following form :—



It is thus both a 10-feet bed measure, and a 10-feet line measure, intended to be of equal length, and subdivided into feet, with further subdivisions of the first foot into 12 inches, and the first inch into tenths. The bar which bears the defining line is 2 inches square in central section. The rectangular ends project nearly $1\frac{1}{2}$ inches, and their measuring surfaces are hardened.

There are also two 10-feet standard bars made of steel. These are end measures, and are distinguished as A and B; they are formed from steel rods $1\frac{1}{2}$ inches in diameter, planed away to the following section :—



Only the rectangular plane *a b* is left as the measuring surface at one end of the bar, and *c d* at the other end, so that successive lengths of 10 feet each can be measured by the two bars when placed in a line, and from the intersected small surface *x*; for instance, for the purpose of verifying a chain of 100 feet. At two feet from each end of the bars, brass ferrules, about three inches in length, are placed, which form handles for lifting the bar; they are fixed upon the bar by four closely-fitting pieces of wood, driven in between each of the two planed surfaces of the bar and the inner circumference of the ferrules.

The standard 6-feet bed and line measure is in every way similar to the 10-feet standard. There is only one 6-feet end bar, which is similar in construction to the 10-feet bars; but as the diminution of its weight for convenient manipulation was not needed to the same extent as that of the 10-feet end measures, somewhat less of the bar is cut away. This 6-feet end bar will be available, in conjunction with the two 10-feet bars, for verifying chains of 66 feet.

Mode of comparison.

These two standard bed and line measures have been verified by means of the new microscopical comparing apparatus.

Upon the upper gun-metal plane of the traversing carriage, (See Plate 1 of Appendix VII.) a stout plank of yellow deal 12 feet long, 9 inches broad, and $1\frac{1}{2}$ inches thick, was placed and steadied by clamps. The plank was further supported towards each end by short diagonal planks of similar section, bearing against the base of the carriage. Each of the standard bars being kept in a strong wooden box, which serves also as a supporting frame during comparisons, the bar in its box was placed on the deal plank and was thus brought under the microscopes.

Comparisons of 10-feet line standard measure.

In the following verification of the 10-feet line standard measure, the first, second, and third lengths of 3 feet each were compared successively with the cast-iron line standard yard No. 63, and the tenth foot with the foot 0—1 on the bronze yard SS.

Airy, p. 81.

The standard temperature of the standard yard No. 63 had been determined in 1857=62·34° F., and the expansion of 36 inches of cast iron=0·000198 in., the standard length of No. 63 at 62° F.=35·99993268 in.

The length of the foot 0—1 on SS, at 62° F., has been determined=11·99997005 in. (See Appendix VII., p. 108).

Although the defining lines of the new 10-feet and 6-feet standard bars seem to the naked eye finely and clearly cut, yet through the microscopes the edges of the lines appear to be irregularly defined, and the lines about $\frac{1}{8}$ inch in thickness, or about 125 divisions of the micrometer; their real thickness is about 0·004 in. Two sets of comparisons were consequently taken in each case, the first from the right-hand edges of the lines, and the second from the left-hand edges, the mean thus being the middle of the line.

Appendix XX.—*continued.*

Comparisons of Standard 10-feet Steel Line Measure with Cast Iron Line Standard Yard, No. 63, and Foot 0–1 on Bronze Yard SS.

No.	Date.	Number of Readings.	Mean Temperature, Fahr.	Compared Standard 10-foot Line Measure.	Comparing Standard Measure.	Micrometers.	Difference of compared from comparing Standard.		Mean.	Standard Length of compared Standard.	Mean Length.
	1870.		°				div.	inch.	inch.	inch.	inch.
(1)	Oct. 6	36	60·5	3-feet (0–3) =	Yard No. 63	Nos. 3 & 4	−28·2	−0·00094	−0·00122	35·99871	35·99875
(2)	„ „	36	60·5	„ =	„	„	−47·3	−0·00154			
(3)	„ 7	12	61·0	„ =	„	„	−28·0	−0·00093	−0·00115	35·99878	
(4)	„ „	12	61·0	„ =	„	„	−40·6	−0·00136			
(5)	„ 6	36	60·5	3-feet (3–6) =	„	Nos. 4 & 1	+61·2	+0·00204	+0·00243	36·00236	36·00242
(6)	„ „	36	60·8	„ =	„	„	+83·1	+0·00281			
(7)	„ 7	12	61·0	„ =	„	„	+67·6	+0·00222	+0·00247	36·00247	
(8)	„ „	12	61·0	„ =	„	„	+86·1	+0·00285			
(9)	„ 6	36	60·8	3-feet (6–9) =	„	Nos. 1 & 2	+44·0	+0·00142	+0·00068	36·00061	36·00048
(10)	„ „	36	60·8	„ =	„	„	− 3·0	−0·00006			
(11)	„ 7	12	62·0	„ =	„	„	+37·3	+0·00125	+0·00042	36·00035	
(12)	„ „	12	62·0	„ =	„	„	−14·6	−0·00041			
(13)	„ 10	24	60·2	1-foot (9–10) =	foot 0–1 on Bronze Yard SS.	„	+ 8·5	+0·00026	−0·00026	—	12·00026
(14)	„ „	24	60·2	„ =	„	„	−23·16	−0·00078			
						∴ Length in inches of 10-feet line standard =					120·00191
						„ feet „ =					10·00016

According to Mr. Sheepshanks's observations, a bar of cast steel, 36 inches in length, expands 0·000207 in. for every 1° Fahr., being only 0·000009 in. in excess of the expansion of cast iron; and as the above comparisons were made at temperatures very nearly approaching 62° F., no correction for the slight difference in the rate of expansion appeared to be requisite.

As the standard 10-feet steel bar expands 0·000690 in. for each 1° F., it follows from the results of these comparisons that it is of the true standard length of 10 feet at 59·24° F.

Comparisons of each foot on 10 feet standard bar.

A further verification was made on 12th and 13th October 1870, of each foot marked upon the standard 10-feet steel bar, by comparison with one of the feet marked on the bronze bar SS.

Comparison of each Foot on the Standard 10-feet Bar.

Length at 62° F. of 0...12 inch SS.=11·99997005
12...24 „ =11·99997985
24...36 „ =11·99995960
in.
12 inches bronze expands 0·0001136 for 1° F.
„ cast steel 0·0000690 „
Excess of expansion of 12 inches of bronze=0·0000446 „

Mean Temperature.	Compared Foot on 10-ft. bar.	Comparing Foot of Standard Yard SS.	Difference of compared Foot.		Ascertained Error of comparing Standard, at 62° F.	Further Correction of compared Foot for Excess of Expansion of 12 inches of Bronze at *t*.	Consequent Length at 62° F.	
			In div. of Microm.	In parts of Inch.			Of compared Foot.	Of compared 3 Ft.
	Foot.	Foot.		in.	in.	in.	in.	
61° F.	0 ... 1 =	0 ... 12	+ 4·6	+0·00008894	−0·00002995	−0·00004466	12·00001433	
62 „	1 ... 2 =	24 ... 36	+20·0	+0·00060242	−0·00004140	—	12·00056102	
62 „	2 ... 3 =	12 ... 24	−23·1	−0·00076102	−0·00002015	—	11·99921883	35·99979
62 „	3 ... 4 =	0 ... 12	−11·8	−0·00041337	−0·00002995	—	11·99955668	
62 „	4 ... 5 =	24 ... 36	+76·5	+0·00240720	−0·00004140	—	12·00236380	
62 „	5 ... 6 =	12 ... 24	+96·8	+0·00304987	−0·00002015	—	12·00302972	36·00495
62 „	6 ... 7 =	0 ... 12	+ 8·0	+0·00021387	−0·00002995	+0·00000893	12·00019285	
62 „	7 ... 8 =	24 ... 36	−15·6	−0·00053825	−0·00004140	—	11·99942035	
62 „	8 ... 9 =	12 ... 24	+14·5	+0·00002880	−0·00002015	—	12·00000865	35·99962

Appendix XX.—*continued.*

These comparisons were made with the two micrometers Nos. 2 and 1, and in the same manner as the previous comparisons. The aggregate lengths of the several three feet agree with the previously determined length of the respective three feet taken together, as nearly as could be expected, considering the thickness of the lines on the steel bar. But the following proportional corrections of the respective three feet in each yard should be made relatively to the length of the yard as previously determined.

Standard length at 62° F. of each of the 10 feet marked upon the 10-feet standard steel bar :—

	in.	in.
Foot 0 ... 1 =	11·99970	
„ 1 ... 2 =	12·00021	
„ 2 ... 3 =	11·99884	
		35·99875
„ 3 ... 4 =	11·99872	
„ 4 ... 5 =	12·00153	
„ 5 ... 6 =	12·00217	
		36·00242
„ 6 ... 7 =	12·00047	
„ 7 ... 8 =	11·99971	
„ 8 ... 9 =	12·00030	
		36·00048
„ 9 ... 10	- -	12·00026
10 feet =		120·00191, or 0·00191 in. in excess.

Comparison of 10-feet line standard with East Indian 10-feet standard.

A comparison of the 10-feet line standard has been made with the East India 10-feet standard bar, which was used for measuring an arc of the meridian in India, and may be denoted as EI.

This standard, which was constructed by Troughton and Simms, is an iron or steel bar of rectangular section, about one inch in breadth and two inches in height. At each end half the height is cut away, like Kater's bars, and a gold stud is inserted, upon which the length is defined by a small dot. The bar is supported in its wooden frame or box by two rollers, each about one-fourth of the length of the bar from each end. There is a pin hole at the middle of the under surface of the bar, into which a pin fixed in the frame fits, and thus steadies it. On the upper surface immediately over the roller supports are two holes for the bulbs of thermometers, the brass frames of these thermometers being attached to the bar by small screws.

No information of the verification of EI has been given to this Department. But it may be stated that Captain Clarke, in his account of the "Comparisons of Standards of Length," published in 1866, describes his comparisons in 1865 of a new Indian 10-feet standard steel bar, IS, the defining lines of which are cut upon gold studs, the result showing the length at 62° F.=120·002450 in., and the coefficient of linear expansion of this steel bar for 1° C.= 0·000063529, or 0·000011435 for 1° F. It may be seen that this rate of expansion of a steel bar differs very little from that determined by Mr. Sheepshanks, viz., 0·00001136.

In the following comparisons the 10-feet line standard was supported as before, and it was found necessary by the limited range of the comparing apparatus to remove EI from its wooden frame and support it upon rollers placed on the deal plank. The result of the first comparison is the mean of 36 readings from the left-hand side of the thick lines of the 10-feet standard, as seen through the microscopes and the middle of the dots of EI. The second comparison was similarly taken from the right side of the defining lines of the 10-feet standard.

Comparison of the 10-*feet Line Standard with the East Indian* 10-*feet Bar.*

			in.
1870. Oct. 18.—56°	10-feet line standard=EI —10 div. of micrometers Nos. 3 and 4	=	—0·00033
56·5	„ =EI — 6·3 „ „	=	0·00022
	Mean	=	0·000275
	Suppose EI equal in length to IS, or	+	0·002450
	And the 10-feet standard being determined	+	0·001910
	Whence 10-feet standard=EI	+	0·000540

This result agrees very nearly with the previous comparison of the new 10-feet standard measure.

Comparisons of two standard 10-feet end bars, Nos. 1 and 2.

A comparison of each of the two 10-feet steel end bars was next made, by means of the microscopical comparing apparatus, with three times the length of 40 inches marked upon the bronze standard measure SS.

The two spherical contact pieces being fixed against the rectangular ends of the 10-feet bars, they were brought under microscopes Nos. 3 and 4. The two other microscopes Nos. 1 and 2 were then placed at 40 inches distance from each other and from Nos. 3 and 4 respectively, all the longitudinal cobwebs being in one straight line. The readings of the defining line of the left-hand contact piece and of 0 in. of SS having been taken with micrometer No. 3, and of 40 in. of SS with micrometer No. 1, SS was moved on rollers along the side of the 10-feet bar until its defining line 0 in. read off with micrometer No. 1 was made to coincide with the previous reading of 40 in. of SS, when 40 in. was read off with micrometer No. 2. The same process was again repeated, and 0 in. read off with micrometer No. 2, and 40 in. with micrometer No. 4, when the defining line of the second contact piece was also read with micrometer No. 4. In each case the parallelism of the two bars was ascertained by means of a gauge, before the readings were taken.

The results of these comparisons were as follows :—

Verification of standard 10-feet end bar No. 1.

1870. Nov. 9.—Mean *t*. of steel 10-feet end bar No. 1=58° F.
„ „ bronze SS =59

		in.
10-feet end bar No. 1+contact pieces=3 (40 in. SS)+3363·5 div.	or	0·107632
Deduct contact pieces	=	0·099232
Whence 10-feet bar No. 1=3 (40 in. SS)	+	0·008400

3 (40 in. SS) at 62° F. = 119·998989 in.
Deduct contraction of 10-feet bronze bar 3° F. = 0·003410

Whence 3 (40 in. SS) at 59° F. = 119·995579

And 10-feet bar No. 1 at 58° F. = 120·003979
Add expansion of 10-feet steel bar for 4° F. = 0·002760

∴ Standard 10-feet end bar No. 1 at 62° F. = 120·006739 or 0·006739 in. in excess.

Appendix XX.—*continued.*

Verification of standard 10-feet end bar No. 2.

1870. Nov. 12.—Mean *t.* of steel 10-feet bar No. 2 = 50° F.

„ „ bronze bar SS = 52° F.

in.

10-feet end bar No. 2 + contact pieces = 3 (40 in. SS) + 3414 div. or + 0·109248

Deduct contact pieces = − 0·099232

+ 0·010016

3 (40 in. SS) at 62° F. = 119·9989893 in.

Deduct expansion of 3 (40 in. SS) = 0·011366

Whence 3 (40 in. SS) for 10° F. at 52° = 119·987623

And 10-feet bar No. 2 at 50° F. = 119·997639

Add expansion of 10-feet steel bar for 12° F. = 0·008280

∴ Standard steel end bar No. 2 at 62° F. = 120·005919 or 0·005919 in. in excess.

Each of the two standard 10-feet steel end bars is thus found to be somewhat larger than the line standard 10-feet measure =120·00191 inches, this length being considered to be equal to the bed measure of the steel bar. A similar slight excess in the length of each of the end bars was found when tested by placing them in the steel bed.

Comparison of 6-ft. Line and Bed Standard.

Comparison of 6-feet line standard.

The 6-ft. line and bed standard measure is constructed of the same shape and material as that of 10-ft. It is divided into six feet, one foot 0—1 being subdivided into 12 inches, and 0·1 inch into tenths. The whole length, 0—6 feet, has been compared with the two cast steel primary standard yards, Nos. 65 and 66, received from the Astronomer Royal in 1866. The compared and comparing standards being both of cast steel, no allowance for difference of expansion of the bars was required to be made. Cast steel No. 65 is equal to 36 inches at 62·22° F., and cast steel No. 66 at 62·11°. Taking the expansion of 36 inches of cast steel for 1° Fahr., according to Mr. Sheepshanks,=0·000207 inch, consequently at 62° Fahr.,—

Airy, p. 81.

Airy, p. 61.

Cast steel yard No. 65=35·99995 inches.

„ No. 66=35·99997 „

Each of the following comparisons is the result of 24 readings of the micrometers, and the mean of two sets of observations with the right and left hand edges of the respective lines of the 6-feet standard, as in the comparisons of the 10-feet line standard.

Comparisons of 6-feet Line Standard with Standard Yards Nos. 65 and 66.

No.	Date.	Mean Temperature, Fahr.	Compared 6-feet Line Standard.	Comparing Standard.	Difference of compared from comparing.		Standard Length of comparing Standard.	Consequent Length of compared Standard.	Standard Length of 6-ft. Bed.
	1870.	°			inch.	inch.	inch.	inch.	
(1)	Oct. 21	56·3	3-feet (0−3) =	Cast Steel Yard No. 65.	−15·3	−0·00048	35·99995	35·99947	71·99661
(2)	„ „	56·3	3-feet (3−6) =	Do.	−88·2	−0·00281	35·99995	35·99714	
(3)	„ 24	56·0	3-feet (0−3) ≏	Do.	− 2·7	−0·00008	35·99995	35·99987	71·99669
(4)	„ „	56·0	3-feet (3−6) ≏	Cast Steel Yard No. 66.	−96·1	−0·00315	35·99997	35·99682	

inches.

∴ Mean standard length of 3 feet 0—3 = 35·99967

„ „ 3—6 = 35·99698

And 6 feet, 0—6 = 71·99665 or 0·00335 in. in deficiency.

The Astronomer Royal's Method of comparing End Measures with Line Measures.

The Astronomer Royal's method of comparing end measures with line measures.

Airy, p. 65.

The following ingenious method of comparing end-measure bars with line-measure bars has been suggested by the Astronomer Royal.

Mr. Airy says—

"Suppose that we have *two* end-bars, each nearly equal in length (as measured from its extreme ends) to the length of a line-bar (as measured from line to line). Suppose also that each of the end-bars has a well sunk to the middle of its depth, with a transverse line cut upon a pin (as in line-measures), the line being not necessarily in the middle of the length of the bar, though it is essential that its distance from the centre of the bar's length be nearly the same in both end-bars. As, generally, one segment of the bar, from the transverse line to the end, will be longer than the other segment, let the longer segment be denoted by +, and the shorter by —. And suppose that the two bars are placed end to end, the + end of one being opposed to the — end of the other, then the distance between their transverse lines will evidently be the sum of the + segment of the first bar and the — segment of the second bar; and the stated conditions as to the similar division of the lengths of the two bars will make that sum so nearly equal to the length of the line-measure, that the difference may be measured by the micrometer apparatus.

"Then interchanging the positions of the end-bars, so that their other ends shall be in contact, the distance under observation will be the sum of the — segment of the first bar, and the + segment of the second bar. Adding together the two measured distances, we have a comparison of the sum of the two end-bars with double the length of the line-bar."

The Astronomer Royal adds,—

"In order to make this determination available, it is necessary further to determine the difference between the whole lengths of the two end-bars. A felicitous suggestion by Mr. W. Simms gave the means of doing this. His proposal was to apply the process above described to *three* end-bars, determining the measure of the sum of each pair of end-bars in reference to double the length of the line-bar; then there are given three equations to find three unknown quantities. The length of each of the end-bars is then found without difficulty."

Appendix XX.—*continued.*

Comparison of 6-ft. Cast Steel End Bar with Bronze End Yards Nos. 69, 45, and Bronze Line Yard No. 30.

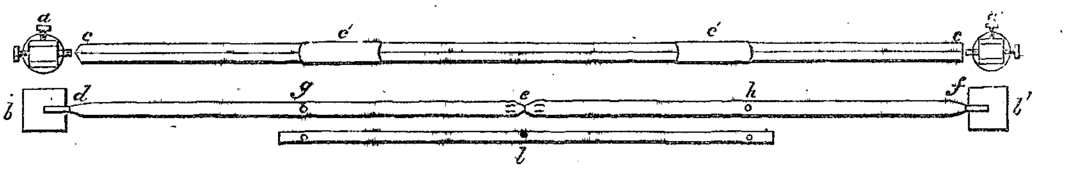
Verification of standard 6-feet end bar by this method.

Owing to the manner in which the official standard 6-ft. bed is constructed, and the magnitude of its defining parts, the length of the 6-ft. bar could not be very accurately ascertained by comparison with the 6-ft. bed. Assuming the length of the 6-feet bed measure to be equal to the 6-feet line measure, marked on the same bar, a provisional comparison of the 6-ft. rod with the 6-ft. bed, gave the length of the rod to be 71·99578 inches. It was, however, considered desirable to determine the length of the new official standard 6-ft. cast steel end bar, by direct comparison with two end standard yards and one line standard yard, according to the Astronomer Royal's method. The length of the 6-ft. bar has been accordingly determined by comparison with the bronze end yards Nos. 45 and 69, and the bronze line yard No. 30.

The 6-ft. bar was first compared with the two end yards, and then the two end yards were compared with the line yard. To effect this it was necessary to use two sets of contact pieces in order to convert the end measures into line measures. With the 6-ft. bar, which has rectangular plane ends, the new contact pieces for rectangular terminations were used. When the spherical ends of these new contact pieces are placed together, the distance from the measuring line on one piece to the line on the other is 0·09923 inch.

The two bronze end yards, with which the 6-ft. bar was compared, and which have spherical terminations, were placed in contact with each other, end to end, their outer terminations being adjusted to the steel rectangular contact pieces for spherical ends. The rectangular terminations were kept in close contact with the spherical ends of the bars by springs attached to the contact apparatus, and which also kept the inner ends of the bars in close contact with each other. The distance between the measuring line on each of these rectangular contact pieces when they are placed in juxtaposition has been determined to be 0·02014 inch.

The following diagram shows the arrangement of standard bars for comparison of the 6-feet standard rod, according to the method suggested by the Astronomer Royal:—



$a\ a^1$ = spherical contact pieces and apparatus.

$b\ b^1$ = rectangular contact pieces and apparatus.

$c\ c$ = 6-feet rod to be compared.

$c^1\ c^1$ = brass handles attached to 6-feet rod.

d e (No. 45) and *e f* (No. 69) = two 3-feet end bars, divided into half yards, by defining lines in sunk wells *g h*.

l = a 3-feet line bar (No. 30).

The lengths of the three bronze bars, as stated in the Astronomer Royal's report (page 80), are as follows:—

End bronze bar No. 45=36 inches at 62·19° Fahr.
„ „ 69= „ 61·67° „
Line „ „ 30= „ 61·66° „

The expansion of 36 inches of bronze for 1° Fahr. being 0·000341 inch, the lengths of these bars at 62° are respectively,—

End bronze bar No. 69=36·00011 inches.
„ „ 45=35·99994 „
Line „ „ 30=36·00011 „

In the following comparisons, however, it is not requisite to know the lengths of Nos. 69 and 45. Any doubt which might arise as to the length of these two bars being affected either by any uncertainty in the plane of the two bars when placed end to end, or in the parallelism of these two bars and the 6-ft. bar with which they were compared, is avoided by resting the determination upon the length of the line yard No. 30, which has been used for the purpose of correcting any possible discordance of this kind.

The end yards No. 45 and No. 69 are divided into half yards by transverse lines on gold studs in sunk wells, and when placed end to end the intermediate length between the middle of each yard gives a centre yard. A second centre yard is obtained by interchanging the positions of the yards. As before, 24 readings were taken for each comparison.

Comparisons of Standard 6-feet Steel Rod (c c) with Two Bronze End Standard Yards, Nos. 45 (d e) and 69 (e f), in Terms of, and with reference to, the Bronze Line Standard Yard No. 30 (l).

No.	Date.	Mean Temperature, Fahr.	Compared.	Comparing.	Difference in Micrometer Divisions.	Difference in parts of an Inch.
	1870.	°			div.	in.
(1)	Nov. 7	54·0	*c, c,* + 0·09923 in. =	*d, e,* + *e, f,* + 0·02014 in.	+ 2705·0	+ 0·08728
(2)	„	54·5	*g, e,* + *e, h,* =	*l.*	− 6·16	− 0·00022
(3)	„	54·5	*c, c,* + 0·09923 in. =	*d, e,* + *e, f,* + 0·02014 in.	+ 2763·0	+ 0·08908
(4)	„	54·0	*h, f,* + *d, g,* =	*l.*	− 4·0	− 0·00011

Reductions of Comparisons.

in.
Expansion of 6 feet of bronze bar =0·000682 for 1° F.
„ „ cast steel bar =0·000414 „

No.	Compared.	Comparing.	Difference of Compared.	Correction of Comparing for Excess of Expansion.	Difference of Compared *t.* = 62°.	Standard Length of Comparing.	Standard Length of Compared.
			inch.	inch.	inch.	inch.	inch.
(1)	*c, c,*	= *d, e,* + *e, f,*	+ 0·00819	− 0·00214	+ 0·00605	71·99989	72·00594
(2)	*g, e,* + *e, h,*	= *l.*	− 0·00022	—	− 0·00022	36·00011	35·99989
(3)	*c, c,*	= *d, e,* + *e, f,*	+ 0·00999	− 0·00201	+ 0·00798	71·99989	72·00798
(4)	*h, f,* + *d, g,*	= *l.*	− 0·00011	—	− 0·00011	36·00011	36·00000

Appendix XX.—*continued.*

Hence it would appear that the length, at 62° F., of the two end bars No. 45 and No. 69, which had previously been determined =72·00005 inches, has now been found to be =71·99989 inches, being a difference in deficiency of 0·00016 inch; and consequently that the mean length of the new standard 6-feet end bar at 62° =72·00691 inches.

All these bars now sufficiently verified as commercial standards.

As these 10-ft. and 6-ft. standards are intended to be used as commercial standards only, the results of these comparisons may be considered as sufficiently accurate, and the standard length of the several bars to have been thus determined.

10-feet bar to be marked with defining lines on platinum studs in sunk wells.

But as 10-ft. standard bars are used for the measurements of surveys in which the highest accuracy is required, I have proposed, after consultation with Mr. James Simms, to make the 10-ft. steel standard bed, shown in page 1, available also as a scientific line standard, by defining lines being marked on platinum studs in wells sunk to half the height of the bar, viz., at 0, 3, 5, 6, 9, 10.

And second carriage, with the requisite supporting rollers, to be furnished.

The arrangements for the support of the 10-feet and 6-feet bars, described in the first part of this Paper, were intended to be provisional only, and it is quite evident that additions are required to the comparing apparatus for properly supporting the bars in order that standard measures of this length may be compared with determinate accuracy. It is therefore proposed to have a second carriage constructed, to some extent similar to that now in use, of which a description and drawing is contained in Paper XIX., and that additional iron rails be laid down for the new carriage to travel upon. When the two carriages are required to be used together, and are placed at the proper distance from each other, they can be connected so as to be moved with one action, and thus many of the detailed arrangements of the first carriage may be dispensed with in the second carriage. Sets of lever rollers for supporting these long bars are also requisite.

For carrying out these arrangements, estimates of the expense have been furnished by Messrs. Troughton and Simms, and the necessary application has been made to the Treasury for their sanction. This sanction having now been obtained, no time will be lost in proceeding with the work.

PART 2.—VERIFICATION OF NEW GLASS STANDARD WEIGHTS.

CONTENTS.

GLASS STANDARD IMPERIAL WEIGHTS.

Page
Construction and composition of glass standard imperial weights - - - - - - - - - 234
Their form and denominations - - - - - „
Mr. Oertling's report on their construction - - - „
Upon what unit of weight their verification to be based - „
Quartz standard lb. Q - - - - - - - 235
Its verification by Professor Miller in 1846 - - - „
Difference of weight of standard air displaced by Q, PS, and W - - - - - - - - - - „
Q, the unit of weight for glass imperial weights - - „
Reverification of Q - - - - - - - - „
Further comparisons of Q with PS - - - - - 236
Results of these comparisons - - - - - - 237
Additional comparisons and the results - - - - 238
Density of the new glass standard weights - - - „
Effect of this density in comparing glass weights with brass weights - - - - - - - - - 240
Verification of new glass standard weights G 7 lb. to G 1 oz. „
Standard weight of new glass standard weights - - 241
Proposed construction of larger standard weights of solid glass - - - - - - - - - „

GLASS STANDARD METRIC WEIGHTS.

Page
Unit of weight for glass metric weights - - - - 241
Construction of quartz kilogram 𝔖 - - - - - - „
Its comparison by Steinheil with other crystal kilograms - „
Its description and cost - - - - - - - 242
Density and expansion of quartz - - - - - „
Steinheil's determination in 1837 - - - - - „
M. Fizeau's later determination of density of quartz - „
Table of coefficients of cubic expansion of quartz - - 243
Determination of density of 𝔖 - - - - - - „
Comparisons of 𝔖 with 𝔗 - - - - - - - „
Comparison of 𝔖 with 𝔎𝔅 - - - - - - 244
Invariableness of quartz weights shown by Steinheil - - 245
Report of Austrian Commission in 1870, on crystal kilogram $\odot^k$ - - - - - - - - - „
  Their corrected weight of $\odot^k$ - - - - - 246
  Austrian standard weights and their metric equivalents „
  Remarks on Report of Austrian Commission - - „
  Volume and density of Kilogramme des Archives - „
  How stated weight of 𝔖 affected by this Report - - „
𝔖 unit of weight for glass metric weights - - - 247
Verification of glass metric weights adjusted with mercury, series 𝔓:
  Description of these weights adjusted with mercury - „
  Determination of their density - - - - - „
  Their actual comparisons - - - - - - „

Verification of Glass Standard Imperial Weights.

Construction and composition of glass standard Imperial weights.

The Standards Commission being of opinion that it would be desirable to ascertain how far it might be expedient to construct standard weights of glass, as being little liable to deterioration or variation in weight from oxidation or friction, Mr. Oertling was directed to place himself in communication with Messrs. Chance of Birmingham, for this purpose.

It was considered that the ordinary hard green bottle glass would be the most suitable for durable standard weights, being free from lead. The composition of the glass used by Messrs. Chance was as follows:—

Silica - - -	72·5 per cent.
Soda - - -	13·0
Chalk - - -	13·5
Traces of manganese and arsenic	1·0

Their form and denominations.

The form of the weights was directed to be the same as that of the official standard imperial weights, spherical with a knob. The first set of glass weights constructed consisted of eight weights of the following denominations:—

7 and 4 lbs., hollow weights, nearly filled with lead shot.
2 and 1 lb., 8, 4, 2, 1 oz., being solid glass weights.

Mr. Oertling's report on their construction.

These glass standard weights were completed and delivered at the Standards Department on 17th Sept. 1870 by Mr. Oertling. In his report dated that day, he states,—

"The two weights, 7 lbs. and 4 lbs. are hollow, filled with shot and the aperture closed with a glass stopper. For a long time I was unable to find a ready means of fixing the glass stoppers in such a manner that the weights would at once be ready for adjustment. In the end I decided upon dispensing with cement altogether.

"The apertures of the two hollow weights in this set are slightly conical and highly polished. After filling the weight with shot the stopper was placed in the aperture, and while slightly pressing with the finger upon the stopper, the weight itself was struck with a light mallet in order to give a jar to the whole mass. By this means the stopper was forced into the aperture as far as could be without splitting the bottle; at the same time I believe that nothing but boring out the stopper would be able to remove it.

"In making more weights of a similar character, the knob might have only a very small surface on the top, and the knob and stopper be polished off together.

"With reference to the smaller weights, I beg to say that the bottom of these weights is not so well finished as we should now be able to do them. Being much too heavy when sent up from Messrs. Chance, we were compelled to grind so much from the bottom that it removed the cavity and rounded edge. Future weights, however, would be delivered in the same form as the two hollow weights.

"The price of this single set of weights now sent, including Messrs. Chance's charge of 4*l.* for their experimental work, and mahogany box, is 14*l.*; if more be required, such a set as now delivered would cost 8*l.*"

Upon what unit of weight thei

In regard to the verification of these glass standard weights, attention may be drawn to the only objection that

Appendix XX.—*continued.*

Verification to be based. Miller, p. 894.

has been raised to the use of weights made of such a material, that is to say, the large amount of air displaced by them, entailing the necessity, in order to obtain accurate results, that the barometer and thermometer should be observed with extreme care during any comparisons with standard weights of any ordinary metal. The relatively small density of glass also makes it of some importance to consider what may the most proper standard unit of weight upon which the verification of these glass imperial standard weights shall be based.

Standard quartz lb. Q.

The imperial standard lb. made of quartz, now in the Standards Department, which was constructed under the sanction of the Standards Committee of 1843, was verified by Professor Miller in 1846, being denoted as Q. It was intended that the apparent weight in air of Q should be intermediate between that of a lb. of platinum and a lb. of brass, approaching more nearly to the latter than the former.

Miller, p. 895.

The density of Q was found by Professor Miller to be 2·649 at 18° C. At 0° C., Steinheil found the density of the quartz of which his kilogram was made to be 2·6509, and its cubic expansion for 1° C. to be 0·00003255. At this rate of expansion, the density of Q at 0° C. may be taken, from Professor Miller's determination, to be 2·6505.

Its verification by Professor Miller in 1846.

In August 1846, Professor Miller made 200 weighings of Q with the imperial standard platinum lb. PS, which were grouped in five sets of 20 comparisons each, or 40 weighings. The weight in air of Q being about 0·4 grain less than PS, this exact weight was added to the pan in which Q was placed, in order to make the balance oscillate. The results of the five sets of comparisons were as follows:—

No.	—	t.	b.	Result in a Vacuum.
	gr.	°	mm.	gr.
(1)	Q ≏ PS – 0·40229	20·31 C.	760·35	Q = PS + 2·36801
(2)	Q ≏ PS – 0·40023	20·29	759·93	Q = PS + 2·36871
(3)	Q ≏ PS – 0·38862	21·03	758·68	Q = PS + 2·36817
(4)	Q ≏ PS – 0·37877	20·80	755·26	Q = PS + 2·36782
(5)	Q ≏ PS – 0·41589	19·99	762·92	Q = PS + 2·36715
Mean -	Q ≏ PS – 0·39716	20·48	759·43	Q = PS + 2·36797

In air, *t.*=65·66° F.; *b.*=29·75 in., when Q was found to displace 3·16588 grains of air, and PS, 0·39644 gr., Q would consequently be 0·40147 gr. lighter than the imperial platinum lb. PS, and 0·23260 gr. heavier than W, the commercial standard lb. of brass, which displaces 1·03051 grains of this air.

As the object of the construction of the new glass standard weights has been that they should serve as models of local standards, in the official comparisons of which, as well as in their use for testing commercial weights, by weighings in air, any small differences arising from variations in the weights of air displaced are not to be taken into account, it is evidently desirable that these glass standard weights should, like Q, approximate nearly to the average weight of standard brass weights, when weighed in air under its variable conditions from changes of temperature and barometric pressure.

Difference of weight of standard air displaced by Q, PS, and W.

But the Standards Commission having at their 30th meeting, on the 30th July 1870, passed a resolution that for all weighings in air the uniform standard temperature of 62° F. ($16\frac{2}{3}$° C.), and the standard barometric pressure of 30 in. at 32° F. (761·986 mm.) should be adopted, it became necessary in carrying out this recommendation with regard to Imperial weights, to consider what is the difference between the weight of an Imperial lb. in this new standard air, of which log. Δ =7·0852825—10, and in that which was previously adopted by Professor Miller, as having been the mean temperature and pressure observed by Schumacher in his comparisons of the lost standard lbs., viz., *t.*=65·66° F., *b.* at 32° F.=29·75 in., or log. Δ=7·07832—10. This difference will be seen in the following table, so far as regards the three primary standard lbs. of platinum, brass, and quartz.

—	Δ at 32° F. in Terms of Maximum Density of Water.	Log. Δ.	Air, log. 7·0783216 – 10.		Air, log. 7·0852825 – 10.	
			Weight of Air displaced in terms of PS in a Vacuum.	Weight of Standard lb. in terms of W.	Weight of Air displaced in terms of PS in a Vacuum.	Weight of Standard lb. in terms of W.
			gr.	gr.	gr.	gr.
Imperial standard platinum lb. PS.	21·1572	1·3254532	0·39644	0·63407 too heavy	0·40282	0·64424 too heavy
Imperial commercial brass lb. (=PS in a vacuum), W.	8·1430	0·9107844	1·03051	—	1·04706	—
Imperial quartz lb. (=PS + 2·36797 gr. in a vacuum), Q.	2·6505	0·4233378	3·16588	0·23360 too heavy	3·21681	0·19820 too heavy

Q, the unit of weight for glass imperial weights.

It will thus be seen that in standard air, log. Δ =7·0852825—10, the weight of the quartz standard lb. Q is 0·44602 gr. less than the platinum lb., and 0·19820 gr. more than the standard lb. of brass, thus approximating somewhat more nearly to the standard lb. of brass than in air, log. Δ=7·0783216—10. As being nearly of the density of solid glass weights, it appears therefore to be expedient that Q be constituted the standard unit of weight for the verification, by weighings in air, of glass weights of every description.

Reverification of Q.

The verification of the solid glass standard weights of 2 lb. and under will therefore be based upon Q. But in order to determine whether any change in the relative weights of the imperial platinum standard lb. PS, and the quartz lb. Q, since their comparisons by Professor Miller in 1846, a similar series of comparisons of Q with PS has now been made. The mode of weighing has been that adopted by Professor Miller, as already described in Appendix V., p. 50, by placing each of the standard weights in a moveable light brass pan, so that the weights can be interchanged in the scales without opening the balance case. The two brass pans are distinguished as X and Y respectively.

Appendix XX.—*continued.*

Further comparisons of Q with PS.

(1.) 1870. Nov. 29. Mean $t.=54·9°$ F. $b.=30·290$ in.

Q+gilt gr. 0·5+X		PS+Y	
49·75		61·0	
50·25		60·7	
51·25		62·5	
51·40	50·66	63·5	61·92
Q+gilt gr. 0·5+Y		PS+X	
51·00		56·65	
51·60		56·65	
52·65		60·25	
52·75	52·00	59·75	58·30
	51·33		60·11
Q+gilt gr. 0·5+gilt gr. 0·02+Y			
61·0			
60·9			
61·3			
61·5	61·175		

Whence 9·175 div.=0·01937 gr., or 1 div. of No. 3 balance =0·00211 gr.

Result, Q≏PS—0·50007 gr.—4·39 div., or 0·00926 gr
∴ Q≏PS—0·50933

(2.) 1870. Dec. 1. $t.=57·0°$ F. $b.=30·564$ in.

Q+gilt gr. 0·5+X		PS+Y	
47·75		63·0	
48·75	48·25	62·5	62·75
Q+gr. 0·5+Y		PS+X	
43·00		71·5	
43·75	43·375	70·4	70·95
	45·813		66·85
Q+gr. 0·5+gr. 0·02+Y			
51·25			
52·00	51·625		

Whence 8·25 div. =0·01937 gr., or 1 div. of balance No. 3=0·00235 gr.

Result, Q≏PS—0·50007 gr.—10·518 div., or 0·02471 gr.
∴ Q≏PS—0·52478

(3.) 1870. Dec. 2. $t.=54·0°$ F. $b.=30·573$ in.

Q+gilt gr. 0·3, 0·2, 0·03, 0·02+X		PS+Y	
53·75		54·50	
53·50		54·50	
53·50		54·35	
53·50	53·562	54·65	54·5
Q+gilt gr. 0·3, 0·2, 0·03, 0·02+Y		Q+X	
61·25		49·00	
60·50		48·75	
60·50		48·50	
60·75	60·75	49·00	48·812
Q+gilt gr. 0·3, 0·2, 0·03+Y			
52·0			
52·5			
52·5			
52·0	52·25		

Whence 8·5 div.=0·01937 gr., or 1 div. of balance No. 3=0·00228 gr.

Result, Q≏PS—0·54931 gr.+2·75 div., or 0·00513 gr.
∴ Q≏PS—0·54418

Appendix XX.—*continued.*

1870. Dec. 8. *t.*=50·18° F. *b.*=29·782 in. (with no fire in the room).

Q+gr. 0·5=X		PS+Y	
47·6		40·5	
48·1		40·5	
46·5		43·9	
46·5		43·5	
	47·175		42·1
Q+0·5 gr.+Y		**PS+X**	
53·0		36·75	
53·5		36·50	
54·0		37·50	
52·5		37·00	
	53·5		36·9375
Q+gr. 0·5+gr. 0·02+Y			
62·25			
62·50			
62·00			
62·50			
	62·3125		

Whence 8·8125 div.=0·01937 gr., or 1 div. of balance No. 3=0·00220 gr.

Result, Q≏PS—0·50007 gr.+5·409 div., or 0·01189 gr.
∴ Q≏PS—0·48818

(5.) 1870. Dec. 21. *t.*=50·04° F. *b.* =29·829 in. (with no fire in the room).

Q+gilt gr. 0·5+X		PS+Y	
46·5		42·0	
47·5		42·5	
	47·0		42·25
Q+gr. 0·5+Y		**PS+X**	
48·0		46·0	
48·9		46·25	
	48·45		46·125
Q+gr. 0·5+gr. 0·02+Y			
58·25			
58·25			
	58·25		

Whence 9·8 div.=0·01937 gr., or 1 div. of balance No. 3=0·00197 gr.

Result, Q≏PS—0·50007 gr.+3·54 div., or 0·00699 gr.
∴ Q≏PS—0·49308

The general results of these weighings in air of Q and PS, when reduced to a vacuum, are as follows :—

Results of these comparisons.

Date.	Weighings in Air.	*t.*	*b.* at 32° F.	Weight of Air displaced by			Result in a Vacuum.
				Q + 0·5 gr. of brass.	PS.	Excess by Q.	
	gr.	° F.	in.				
1870, Nov. 29 -	Q≏PS−0·50933	54·90	30·290	3·29613	0·41276	2·88337	Q=PS+2·37404
„ Dec. 1 -	Q≏PS−0·52478	57·00	30·564	3·31167	0·41470	2·89697	Q=PS+2·37219
„ „ 2 -	Q≏PS−0·54418	54·00	30·573	3·33320	0·41740	2·91588	Q=PS+2·37162
„ „ 8 -	Q≏PS−0·48818	50·18	29·782	3·27283	0·40994	2·86289	Q=PS+2·37471
„ „ 21 -	Q≏PS−0·49308	50·04	29·829	3·27840	0·41054	2·86786	Q=PS+2·37478
						Mean -	Q=PS+2·37347

Appendix XX.—*continued.*

The two last sets of weighings on 8th and 21st December were taken without any fire or artificial heat in the room.

The apparent result of these comparisons is to show that some slight change has taken place in the relative weights of Q and PS since 1846, Q appearing to be now 0·00550 gr. heavier than PS, as compared with the mean result of Professor Miller's weighings. As before stated, the observations in 1846 consisted of 5 sets of comparisons, each of 40 weighings; 5 sets of comparisons have also now been made, three of them of 20 weighings each, and two of 10 weighings. But the weighings in 1846 were taken at a far higher temperature than in 1870, and with the greatest precautions in noting the actual temperature and barometric pressure. The difference of the results may be owing to a slight condensation of moisture on the larger surface of Q at the lower temperature of the more recent weighings. This effect is to some extent shown in the difference of the results in the five comparisons now taken, an increased weight being assigned to Q from the two last comparisons. Another cause in the difference of the weighings may be, that after the recent weighings had been completed some oxidation was found in the mercury of the barometers of the Standards Department, which may have given rise to some slight error in the noting of the barometric pressure during the observations.

Addition comparis of Q wit PS, and results.

When the results of these new comparisons of Q and PS were communicated to Professor Miller, he expressed his opinion that the disagreements with the results of his comparisons were greater than he should have expected. Upon a close examination of Q some slight stratches were found, which must have existed when the weight was constructed, and as these might have afforded some lodgement for dirt, the quartz weight was carefully washed with alcohol, and pure water; after which the four following further series of comparisons were made with Barrow's balance, which had been used by Professor Miller for his weighings of Q and PS in 1846:—

Further Comparisons of Q and PS.

No.	Date.	Number of separate Comparisons.	Weighings.	Value of one Div. of Balance.
	1871.		gr. gr.	gr.
(1)	March 1 -	3	Q + 0·5 of platinum ≏ PS − 0·03162	0·00937
(2)	„ 4 -	6	„ ≏ PS + 0·01731	0·01047
(3)	„ 14 -	6	„ ≏ PS + 0·04602	0·00360
(4)	„ 13 -	6	„ ≏ PS + 0·01644	0·00347

(1) was taken by Gauss's method, but without interchangeable pans; the centre of gravity of the balance had previously been adjusted for small weights, and was too low for Q and PS.

(2) was similarly taken, except that interchangeable pans Y and X were used.

(3) (4) were taken by Borda's method of counterpoise, the centre of gravity of the balance having been raised and its sensibility increased.

Reductions of Weighings.

No.	Weighings in Air.	t.	b. at 32°.	Weight of Air displaced by			Result in a Vacuum.
				Q + 0·5 gr. of Platinum.	PS.	Excess by Q.	
	gr.	°C.	mm.	gr.			
(1)	Q≏PS − 0·53169	13·14	773·53	3·31209	0·41447	2·89762	Q=PS+2·36593
(2)	Q≏PS − 0·48276	13·22	762·37	3·26000	0·40824	2·85176	Q=PS+2·36900
(3)	Q≏PS − 0·45405	14·56	757·73	3·22402	0·40373	2·82029	Q=PS+2·36624
(4)	Q≏PS − 0·48363	12·17	759·24	3·25917	0·40814	2·85103	Q=PS+2·36740
						Mean - - -	Q=PS+2·36714

In all these reductions of the weighings of Q and PS the cubic expansion of quartz has been taken as determined by Steinheil and employed by Professor Miller. If the more recent determination of the cubic expansion of quartz by M. Fizeau (see p. 243) were taken, the result would be merely to increase the stated weight of air displaced by Q by 0·00010 gr.

The weighings of Q≏PS have presented greater discordances than have occurred in any other comparisons of primary standards in the Standards Department. These discordances are probably attributable to considerable variations in the hygrometric condition of the air of the room in which the weighings of the two standards, differing so materially in density, took place. But the mean results of the last weighings approximate much more closely to the results of Professor Miller's weighings; and if the two last series of comparisons (3) (4) taken after the adjustment of Barrow's balance were alone taken, the mean result would be Q=PS+2·36682, agreeing almost exactly with Professor Miller's result. Upon the whole it may safely be assumed that no actual change has taken place in the absolute weight of Q as compared with PS, and that the weight of Q may consequently be taken as determined by Professor Miller.

Density the new standard glass weights.

It has been considered desirable to determine with sufficient accuracy the density both of the new solid glass weights and the hollow glass weights filled with lead shot, in order to ascertain the precise difference of weight which may be caused by variations in the weight of air displaced by such glass weights.

The density of the 1 lb. and 2 lb. weights only has been ascertained; their mean density being taken as that of all these solid glass weights. The glass weights of 4 lb. and 7 lbs. being filled with lead shot, their density has been separately determined.

Appendix XX.—*continued.*

Density of Glass Weight, 2 lb.

1870. Nov. 7. Glass 2 lb., assumed weight in air ($t.=12·78°$ C., $b.=758·94$ mm.)		= 14,000·000 gr.
„ weighed in water against bronze weights ($t.$ of water 12·50°) - - - - - -		= 8,438·327
		5,561·673
Add weight of air displaced by 8,438·327 gr. of bronze		= + 1·275
∴ Weight of water displaced by glass 2 lb. - -		5,562·948
Log. weight of water displaced - - -	3·7453050	
Add log. W_t - - - - - -	0·0002406	
	3·7455456	
Deduct log. $(1+eG_t)$ - - - - -	0·0001475	
Whence log. v glass 2 lb. - - -	3·7453981	
Deduct from log. weight in air of glass 2 lb., in grains	4·1461280	
Whence log. Δ glass 2 lb. - - -	0·4007299	
∴ Δ glass 2 lb. - - - -		= 2·5161

Density of Glass Weight, 1 lb.

1870. Nov. 9. Glass 1 lb., assumed weight in air, $t.=12·22°$ C., $b.=758·94$		= 7,000·000 gr.
„ weighed in water, = 12·67° „		= 4,223·011
		2,776·989
Add weight of air displaced by 4,223·011 gr. of bronze		= 0·638
∴ Weight of water displaced by glass 1 lb.		2,777·627
Log. weight of water displaced - - - -	3·4436738	
Add log. W_t - - - - - - -	0·0002385	
	3·4439123	
Deduct log. $(1+eG_t)$ - - - - - - -	0·0001462	
Whence log. v glass 1 lb. - - - -	3·4437661	
Deduct from log. weight in air of glass 1 lb., in grains -	3·8450980	
Whence log. Δ glass 1 lb. - - - - -	0·4013319	
∴ Δ glass 1 lb. - - - - - -		= 2·5196

Hence mean Δ of solid glass weights = 2·5179, and log. Δ = 0·4010309

Density of Glass (loaded with Lead) 4 lb. and 7 lb. Weights.

———	Glass 4 lb.	Glass 7 lb.
1870. November 11. $t.$ air - - =	12·11° C.	12·11° C.
$t.$ water - - =	9·14	8·9
$b.$ - - =	751·14 mm.	751·14 mm.
	gr.	gr.
Assumed weight in air - - - - - - - -	28,000·000	49,000·000
Weighed in water against bronze weights - - - - - -	21,134·499	37,062·002
	6,865·501	11,937·998
Add weight of air displaced by bronze weights - - - - -	3·166	5·553
∴ Weight of water displaced by glass weights - - -	6,868·667	11,943·551
Log. weight of water displaced - - - - - - -	3·8368724	4·0771324
Add log. W_t - - - - - - - - -	0·0000853	0·0000799
	3·8369577	4·0770525
Deduct log. $(1+e\,G_t)$ - - - - - - - -	0·0001055	0·0001109
Whence log. v glass weights - - - - - - -	3·8368522	4·0769416
Deduct from log. weight in air, in grains - - - - - -	4·4471580	4·6901961
Log. Δ glass weights - - - - - - -	0·6103058	0·6132545
∴ Δ glass weights - - - - - -	4·0767	4·1044

Appendix XX.—*continued.*

Effect of this density in comparing glass weights with brass weights.

With the density of 2·5179, a glass 1 lb., weighing like Q in a vacuum 2·36797 gr. more than the platinum standard lb., will displace in air log. Δ 7·0852825—10, a weight of air = 3·38636 gr., and would consequently weigh 0·02867 gr. more than W, and 0·16955 gr. less than Q.

The results of weighing in air, of various temperatures and barometric pressures, metric weights differing considerably in their density, has already been shown in Appendix XII. It has been in like manner found, in regard to Imperial weights, that the effect of variations in the temperature and pressure are as follows:—

Verification of new standard glass weights.

Comparisons of New Standard Glass Weights G 7 lb. to G 1 oz.

Weight in Air; Temperature and Barometric Pressure, viz.:—	Weight of Air displaced by 1 lb.		Excess of Weight of Air displaced by Glass lb.
	Of Brass of the Density of W. Δ=8·1430. log. Δ=0·9107844.	Of Glass of Mean Density. Δ=2·5179. log. Δ=0·4010309.	
	gr.	gr.	gr.
Air, t.=62° F., b.=30 in., log. Δ=7·0852825−10 -	1·04706	3·38520	2·33814
„ t.=62° F., b.=29 in., log. Δ=7·0705189−10 -	1·01206	3·27206	2·26000
„ t.=32° F., b.=30 in., log. Δ=7·1123704−10 -	1·11349	3·60112	2·48763

Thus with no change of temperature, a variation in the atmospheric pressure of 1 inch, either higher or lower, would cause an apparent diminution or increase in the glass lb., as compared with the brass lb., of 0·05814 gr.; and with no change of barometric pressure, a variation of 30° Fahr. in the temperature, higher or lower, would cause an apparent increase or diminution in the relative weight of the glass lb., of 0·14949 gr., being about 0·005 gr. for each 1° F.

The greatest difference from the mean which could be caused by extreme variations of temperature and barometric pressure in a glass weight of 1 lb., as compared with a brass weight, could not exceed 0·25 gr.; nor would such difference affect a glass weight of 14 lb., which is probably the largest denomination for solid glass weights, to a greater extent than about 3 grains, or about $\frac{1}{30000}$th part. In glass weights loaded with lead, and therefore with an increased density, the difference would of course be diminished in a corresponding degree.

The slight discordances thus arising from the difference of the weight of air displaced by glass weights and brass weights, may also be seen in the following comparisons of the new glass weights, where the larger weights have been compared both with other glass weights or with Q, and with gilt gun-metal weights.

No.	Date.	Compared	≏	Comparing.	Result in Divisions.	Value of 1 div. of Balance.	Result in grains.	t. Fahr.	b.
	1870.				div.	gr.	gr.	°	in.
(1.)	Dec. 15	G 1 lb. + 0·1 + 0·05 gr.	≏	Q - -	− 2·275	0·00311 No. 3	−0·00708	53·70	29·374
(2.)	„ „	G 1 lb.	≏	Gilt lb. No. 34 + 0·05 gr.	+10·168	0·00188 „	+0·01911	54·50	29·372
(3.)	„ 14	G 2 lb. + 0·3 + 0·1 gr.	≏	Q + G 1 lb. -	− 3·531	0·02297 No. 5	−0·08111	51·50	29·166
(4.)	„ 15	G 2 lb. + 0·5 + 0·1 gr.	≏	Q + G 1 lb. -	+ 2·106	0·00153 No. 3	+0·00323	53·30	29·371
(5.)	„ „	G 2 lb. + 0·3 gr.	≏	Gilt lbs. Nos. 33, 34	− 2·331	0·00278 „	−0·00649	53·30	29·371
(6.)	„ 14	G 4 lb.	≏	G 2 lb. + 1 lb. + Q + 5, 1, 0·5, 0·3, 0·2 gr.	+ 7·568	0·00210 „	+0·01589	53·30	29·174
(7.)	„ „	G 4 lb.	≏	Gilt lbs. Nos. 31, 32, 33, 34 + 1, 0·5, 0·3, 0·2 gr.	+10·131	0·00171 „	+0·01732	53·70	29·178
(8.)	„ 16	G 7 lb. + 3 gr.	≏	G 4 lb. + 2 lb. + 1 lb.	− 2·537	0·24010 No. 1	−0·60925	50·50	29·897
(9.)	„ „	G 7 lb.	≏	Gilt lbs. Nos. 31, 32, 33, 34 + bronze lbs. Nos. 35, 36, 37 + 3 gr.	+10·487	0·04610 No. 2	+0·48242	50·35	29·892
(10.)	„ „	G 7 lb.	≏	Do.	+ 7·437	0·05850 „	+0·43509	49·8	30·019
(11.)	„ 7	G 8 oz. + 8 oz. C	≏	G 1 lb. - -	−15·850	0·00274 No. 3	−0·04343		
(12.)	„ „	8 oz. C	≏	G 8 oz. - -	− 7·268	0·00171 „	−0·01243		
(13.)	„ 8	G 4 oz. + 4 oz. C	≏	G 8 oz. - -	−18·750	0·00161 „	−0·03018		
(14.)	„ 10	4 oz. C	≏	G 4 oz. - -	+15·968	0·00120 „	+0·01916		
(15.)	„ 8	G 2 oz. + 2 oz. C	≏	G 4 oz. - -	+17·706	0·00167 „	+0·02957		
(16.)	„ 12	2 oz. C	≏	G 2 oz. - -	− 8·410	0·00165 „	−0·01390		
(17.)	„ „	G 1 oz. + 1 oz. C	≏	G 2 oz. - -	−11·162	0·00137 „	−0·01529		
(18.)	„ „	1 oz. C	≏	G 1 oz. - -	−10·068	0·00181 „	−0·01819		

The counterpoises of the glass weights from 8 oz. to 1 oz. denoted as C, were all composed of glass, so as not to differ in density from the glass weights.

Appendix XX.—*continued.*

Results of Comparisons.

			Ascertained Error of Glass Standard Weights, in terms of the Brass commercial Standard W, when weighed in Air, without allowing for Difference of Air displaced.				Apparent diminished Weight by Comparison with Bronze Standards.
	—		Compared with Quartz or Glass Standard Weights.		Compared with Bronze Standard Weights.		
		gr.		gr.		gr.	gr.
(1.)	G 1 lb. ≏ Q	−0·15183		+0·04637		—	—
(2.)	G 1 lb. ≏ Gilt lb. No. 34	+0·06922		—		+0·06458	−0·01821
(3.)	G 2 lb. ≏ Q+G 1 lb.	−0·68057	−0·43600	−0·39412			
(4.)	G 2 lb. ≏ Q+G 1 lb.	−0·59680	−0·35223			—	—
(5.)	G 2 lb. ≏ Gilt lbs. Nos. 33 and 34.	−0·30625		—		−0·31207	−0·08205
(6.)	G 4 lb. ≏ Q+G 1 lb. + G 2 lb.	+7·01725		+6·86770		—	—
(7.)	G 4 lb. ≏ Gilt lbs. Nos. 31, 32, 33, 34.	+7·01868		—		+7·00130	−0·13360
(8.)	G 7 lb. ≏ G 1 lb.+G 2 lb. + G 4 lb.	−3·60898		+2·91097		—	—
(9.)	G 7 lb. ≏ Gilt lbs. Nos. 31, 32, 33, 34 + bronze lbs. Nos. 35, 36, 37.	+3·48216		—	+3·45580	+3·43213	−0·52116
(10.)	G 7 lb. ≏ Do.	+3·43482		—	+3·40846		
(11.) (12.)	G 8 oz.			+0·03655			
(13.) (14.)	G 4 oz.			+0·02379			
(15.) (16.)	G 2 oz.			+0·03363			
(17.) (18.)	G 1 oz.			+0·01826			

It is proposed that Mr. Oertling should reduce the weight of the 4 lb. and 7 lb. glass standards loaded with lead by the amount of error thus shown. He reports that he had much difficulty in adjusting these two weights. The shot is loose inside the glass. It would be better that the shot should be fixed with cement or otherwise.

The standard weight of the other glass standard weights may be considered as determined in terms of Q —0·19820 gr., being the ascertained excess of Q in terms of W in standard air log. 7·0852825—10, and which is now adopted as the standard unit for glass weights.

Standard Weight of New Solid Glass Standard Imperial Weights.

Standard weight of new glass weights.

	gr.		gr.
Glass 2 lb.=	13,999·60588	Glass 4 oz.=	1,750·02379
„ 1 lb.=	7,000·04637	„ 2 oz.=	875·03363
„ 8 oz.=	3,500·03655	„ 1 oz.=	437·51826

Proposed construction of larger weights of solid glass.

It is also proposed that Mr. Oertling should construct a solid glass weight of 14 lbs., which would be about the size of a 56 lb. brass weight, glass being nearly one-fourth of the density of brass, with a view of ascertaining the expediency of having sets of local standard weights of solid glass consisting of nine weights from 14 lb. to 1 oz. A similar set of glass metric weights might perhaps then be made from 10 kilograms downwards, to be used for similar purposes.

New Glass Standard Metric Weights.

Unit of weight for glass Metric weights.

For the reasons already assigned for establishing a standard lb. of quartz as the unit of weight for glass imperial weights, it may be considered desirable that a quartz kilogram should be established as the unit for glass metric weights.

Construction of quartz kilogram 𝔖.

The quartz kilogram 𝔖 was constructed for the Standards Department by Dr. von Steinheil at Munich, in accordance with the recommendations of the Standards Commission, as expressed at their meetings of 29th May and 23rd June 1869. The crystal of which it is made was a Brazilian pebble of large size and nearly globular, which was procured through the kind offices of Mr. James Simms, and transmitted from London to Munich. The cost of this piece of crystal was 2*l*.

Its comparison by Steinheil with other crystal kilograms.

The completion of the kilogram was announced by Steinheil on 14th July 1870. He stated that it had been verified with his unit of metric weight in crystal, the result of 50 comparisons of 𝔖 with his two half kilograms in rock crystal $\mathfrak{W}^1$ and $\mathfrak{W}^2$ being

$$\mathfrak{S} = \odot^k - 0{\cdot}119 \text{ mgr.}$$

$\odot^k$ denotes the second of the new crystal kilograms which had previously been constructed by Steinheil from crystals procured by him in Switzerland. They are of cylindrical form, the height somewhat exceeding the diameter and the edges rounded. The axes of the cylinders lie parallel to the axis of the crystal.

The first crystal kilogram constructed by Steinheil, denoted as $\mathfrak{B}^k$, became the possession of the Neapolitan Government in 1846. A description of this kilogram and of its verification at Paris with the kilogramme des Archives, in May 1837, is contained in Steinheil's paper, "Ueber das Bergkrystall kilogramm," printed in the "Abhanglungen der K. Akademie der Wissenschaften zu "München." There are some slight defects in the crystal, but these are stated to have no influence whatever on its weight. Its density was determined by Steinheil to be 2·650962, and the mean coefficient of linear expansion of the crystal = 0·0000108. The true weight of $\mathfrak{B}^k$ in a vacuum was found=1000·01411 grm., with a probable error of 0·05 mgr.

Steinheil's account of $\odot^k$ and its verification is contained in his paper "Ueber genaue und invariable Copien des Kilo- "grammes und des Metre prototyp," printed in the 27th vol. of the "Denkschriften der Mathematisch naturwissen- "schaflichen Classe der K. Akademie der Wissenschaften," at Vienna, in 1867. $\odot^k$ is stated to be entirely free from flaw or defect. It was constructed for the Austrian Government, and is now at Vienna, having been verified by comparison with $\mathfrak{B}^k$ in October and November 1846. Forty-three separate comparisons were made, and the mean error was only 0·02 mgr. The result showed $\odot^k = \mathfrak{B}^k - 0{\cdot}01426$ grm., and consequently $\odot^k = 1000$ grm.—0·00015, or

$$\odot^k = 999{\cdot}99985 \text{ grm.}$$

According therefore to Steinheil's determination,

$$\mathfrak{S} = 999{\cdot}99973 \text{ grm.}$$

The comparisons of 𝔖 were stated by Steinheil to have been made by Professor Voit with the balance of the collection of mathematical instruments at Munich, and he added that computations of the probable errors by the method of least squares were being made, the results of which would be furnished. No account of them has however yet been received in the Standards Department.

Its description and cost.

The surface of the kilogram 𝕾 is highly polished, and the crystal is without a flaw. Like the two other crystal kilograms, its form is cylindrical, the height being about 80^{mm} and diameter 79^{mm}. But its symmetry is marred by three defective places having been cut out from its surface. It has however a faultless surface which can be perfectly cleaned.

The total cost of the construction and verification of 𝕾 was 250 florins, or about *22l.*, being for the mechanical work only. Dr. von Steinheil and Professor Voit gave their valuable services gratuitously, and a vote of thanks to them was passed by the Standards Commission at their meeting of 30th July 1870.

The transmission of 𝕾 to this country was delayed for some time in consequence of the war. In the meantime, the scientific world sustained a great loss by the death of Steinheil on 14th September. On 1st October the kilogram was transmitted from Munich by the sons of Dr. von Steinheil and was received on 7th October at the Standards Department.

Density and expansion of quartz.

In the preceding account of the reverification of the quartz standard lb. Q, it has been stated that the density of the quartz of which this standard was made, was determined by Professor Miller's observations to be 2·6505 at 0° C., agreeing very nearly with Steinheil's determination of the density of his quartz kilogram, viz., 2·6509 at 0° C. For this determination Professor Miller assumed the coefficient of cubic expansion of quartz for 1° C. to be 0·00003255 as found by Steinheil.

My attention has since been drawn by Professor Miller to M. Fizeau's determination of the expansion of quartz, as given in the Annuaire du Bureau des Longitudes, which differs to some extent from Steinheil's determination. It may therefore be desirable to state the process by which each result has been obtained.

Steinheil's determination in 1837.

Steinheil's account is contained in his above-mentioned paper, "Ueber das Bergkrystall Kilogramm," in which he gives a detailed description of the verification of his quartz kilogram 𝕭^k with the primary platinum kilogramme des Archives 𝔄, at Paris, in May 1837. The following is a translation from the original German:—

"Determination of the density (Δ) and coefficient of expansion (x) of the quartz kilogram 𝕭^k.

"Bessel shows in No. 163 of the Astronomical Transactions that the density of a body is to be determined by its being weighed in air and in distilled water, whilst the true weight of the body is to be deduced from both operations by observations of the equations thus given. This determination requires, however, the coefficient of expansion of the body to be known beforehand, as it is impracticable to make the weighings at the exact temperature of 0° C., and in water at its maximum density. But the coefficient of expansion of quartz has, so far as I know, never yet been determined, much less could the alteration of its volume be determined, since the contraction of all crystals varies according to the different axes of the crystallized parts. For the present purpose, however, it is requisite only to know the change of volume caused by the temperature, without concerning ourselves as to the direction in which the expansion occurs. We wish to learn in regard to a body which expands equally in all directions, x being equal to so much for 1° C., how much this x itself comes to, $(1+t\,x)^3$. It is obvious that the mean x cannot well be ascertained by measurement of length, but must be determined by other means. The process of weighing appears to be particularly suitable for this object as specific gravity is a constant quality of all bodies. In such an operation that value must be assigned to the density, which may be found at the temperature of the water in which the body is weighed.

"These considerations lead to the conclusion that the coefficient of expansion of a body may be ascertained through a combination of three weighings, one in air, and the other two in water at different temperatures. This is also, mathematically considered, quite clear; for two weighings, one in air and one in water, are sufficient to eliminate the true weight, and to determine the density; consequently, three weighings, differing materially from each other, will be sufficient, not only to eliminate the true weight and the density, but also to determine a third element, the coefficient of expansion.

"We must, therefore, arrange to weigh the quartz in air and then twice in water, differing as much as possible in temperature. From the three weighings we may ascertain its coefficient of expansion, its density, and its true weight according to the unit of weight with which it is compared.

"All observations of this nature being affected by unavoidable errors, the results of these three weighings are to be accepted only as the approximate values. It is only by numerous observations that the limits of uncertainty can be traced out, and their dimensions ascertained. In order, therefore, accurately to determine the two elements, the density and coefficient of expansion of quartz, we must make many weighings, both in air and in water, the latter at greatly differing temperatures. These observations should, in the first place, be divided into three groups and from them the approximate values of Δ and x be computed; the results should then be subjected to such correction as may most accurately be deduced from the several observations, and then the limits of incidental errors of observation be ascertained."

Dr. Steinheil then gives a description of his balance, which he states to be so sensitive that when loaded with two kilograms, it shows any difference of 0·2 mgr., or the ten millionth part.

The weights used by Steinheil were a series of brass weights (Δ=8·150) from 500 grammes to 1 gramme, with duplicate units, and a third weight of 1 grm. The nominal weight of the whole series was 1,000 grammes, but their verified weight in a vacuum was 1,000·01210 grm.

The mean results of the weighings were as follows:—

(1) In air, $t=18\overset{\circ}{\cdot}40$ C., $b=721\cdot87$ mm. $+$ 𝕭$^k=999\cdot7155$ grm.
(2) In water, $t=23\cdot99$ C., $b=720\cdot74+$ 𝕭$^k=623\cdot4798$.
(3) „ $t=16\cdot82$ C., $b=713\cdot97+$ 𝕭$^k=623\cdot0383$.

By reducing these weighings according to Bessel's formula, which is given by Steinheil (p. 206), together with the requisite correction for the density of the comparing weight to 8·1500, the result is thus stated:—

from (3) $x=0\cdot00001055$ for 1° C.
from (1) (2) $\Delta=2\cdot650895$ „

And by subsequent corrections from taking the probable errors of each element in the comparisons, and reducing them by the method of least squares, the final results are shown by Steinheil,

$$x=0\cdot0000108$$
$$\Delta=2\cdot650962$$

As there are two unknown quantities in the first two of these equations, the approximate values were in the first instance obtained by assuming the very small value of x.

For obtaining these results, the density of quicksilver taken by Steinheil was that determined by Hällström from Brisson's observations =13·59606; the ratio of the density of air and of quicksilver, at 0° C. and $b=760$ mm., according to Biot's and Arago's observations =10475·6; and the increase of volume of air for 1° C., according to Gay-Lussac and Dulong and Petit =0·00375; the coefficient of linear expansion of brass for 1° C. was taken at 0·00001878, and of platinum, 0·00008565 according to Borda's determination.

M. Fizeau's determination of the expansion of quartz is given at p. 417 of the Annuaire du Bureau des Longitudes for 1869, and is as follows:—

Crystalline body.	Coefficient of linear Expansion for 1° C. at 40°, or when the Mean between the extreme Temperatures is 40°.	Variation of the Coefficient when the Temperature or the Mean is greater or less by 1° than 40°.
Quartz or rock crystal, 1st direction - - - -	0·00000781	2·05
„ 2nd direction - - - -	0·00001419	2·38

The mode in which the determination of the expansion of quartz was made by M. Fizeau, is stated by him in the Comptes Rendus de l'Academie des Sciences, Séances du 21 et 28 Mai, 1866. This paper contains also references to former papers by M. Fizeau, fully describing his methods of observing.

Appendix XX.—*continued.*

According to the instructions contained in M. Fizeau's explanatory notes, at p. 419 of the Annuaire du Bureau des Longitudes, his determination may be thus applied to Steinheil's obervations at the following temperatures :—

Highest temperature - -	23°·29 C.
Lowest „ - - -	16·82
Difference - - - - -	6·47
Mean temperature - - -	20·06

1st direction, coefficient of linear expansion at 40° - - - - - - - -	0·00000781
Deduct 2·05 × (40—20·06) 19·94 - -	41
∴ Coefficient in 1st direction - -	0·00000740

2nd direction, coefficient of linear expansion at 40° - - - - - - - -	0·000014190
Deduct 2·38 × 19·94 - - - -	475
∴ Coefficient in 2nd direction -	0·000013715

The coefficient of cubic expansion is found by adding to the coefficient in the 1st direction, twice the coefficient in the 2nd direction.

Whence the coefficient of cubic expansion of quartz for 1° C. between 23°·29 and 16°·82=0·00003483.

If the whole range of ordinary temperatures of air in which weighings are made be assumed to be between 44° and 80° Fahr., the mean being 62° F. (or according to the centigrade scale, 7° to 27°, being an extreme difference of 20° C., or a mean temperature of 17° C.), the mean coefficient of cubic expansion of quartz for all weighings in air will be found by a similar computation to be=0·00003463.

It is now proposed to adopt M. Fizeau's more recent and authoritative determination of the cubic expansion of quartz in all the departmental comparisons of standards in which this element may be required to be taken into account, according to the following table :—

Table of coefficients of cubic expansion of quartz.

Table of Coefficients of cubic expansion of Quartz for 1° C., at the following temperatures.

t.= 0° C.	0·00003347	t.=11° C.	0·00003422
1 „	3353	12 „	3429
2 „	3360	13 „	3436
3 „	3367	14 „	3443
4 „	3373	15 „	3450
5 „	3380	16 „	3456
6 „	3387	17 „	3463
7 „	3394	18 „	3470
8 „	3401	19 „	3476
9 „	3408	20 „	3483
10 „	3415		

Density of Quartz Kilogram 𝔖.

Determination of density of 𝔖.

The density of the quartz kilogram 𝔖 has been determined by the mean of three separate series of comparisons in air and in water with the brass standard metric weights, Series 𝔐, the density of which=8·2463, viz. :—

1871, Feb. 16.	grm.
Ascertained standard weight of 𝔖 - -	=1000·00694
Weight of 𝔖 in water against brass weights t.=8·94, b=766·43 mm. - - -	= 622·81650
	377·19044
Add weight of air displaced by 622·81650 grm. of brass, t.=11·16° C. - - -	= 0·09443
	377·28487

Log. 377·28487 grm. - - -	=2·5766697
+log. W_t - - - - -	0·0000789
	2·5767486
—log. $(1+e\,Q_t)$ - - - -	0·0001220
log. v. 𝔖 -	2·5766266
Deduct from log. weight of 𝔖 -	3·0000031
log. Δ 𝔖 -	0·4233765
∴ Δ 𝔖 - -	2·6508

Similar results were obtained from two other comparisons on the 15th Feb., t. of air=10·47°, t. of water=8·05°, b.=765·85, and on 17th Feb., t. of air=10·16°, t. of water=8·83°, b.=766·59, viz. :—

On 16 Feb. log. Δ 𝔖	= 0·4233765
„ 15 „ „	= 0·4233759
„ 17 „ „	= 0·4233823
Mean log. Δ 𝔖	= 0·4233782
∴ Δ 𝔖	= 2·6508

This determination of the density of 𝔖 differs very slightly indeed from that of the quartz kilogram B^k by Steinheil,=2·6509, and of the quartz ℔. 𝔔 by Professor Miller,=2·6505.

Comparison of 𝔖 with 𝔈.

Comparison of 𝔖 with 𝔈.

The quartz kilogram 𝔖 has been verified in the Standards Department by comparison with the platinum kilogram 𝔈, as follows :—

(1.) 1871. Feb. 14. Mean t. 10·91° C. b.=765·72 mm.

𝔖+400·30 mgr.		𝔈	
50·5		65·25	
51·5		70·00	
51·5		66·75	
	51·16		67·33
		𝔈—2·02 mgr.	
		62·40	
		64·75	
		61·00	
			62·716

Whence 4·615 div. of balance No. 5 =2·02 mgr., or 1 div. =0·4375 mgr.

Result, 𝔖=𝔈—400·30 —8·083 div., or 3·54 mgr.
∴ 𝔖=𝔈—403·84.

(2.) Feb. 15. t.=10·47° C. b.=765·85 mm.

𝔖+400·3 mgr.		𝔈	
47·0		74·0	
49·4		76·0	
51·0		77·0	
	49·13		75·6
		𝔈—2·02 mgr.	
		66·5	
		69·5	
		71·5	
			69·16

Whence 6·5 divisions of balance No. 5 =2·02 mgr., or 1 div. =0·31 mgr.

Result, =𝔈—400·3 mgr.—13·26 div., or 4·12 mgr.
∴ =𝔈—404·42.

(3.) Feb. 18. t.=11·6° C. b.=768·54 mm.

𝔖+ 400·3 mgr.		𝔈	
45·0		66·5	
43·5		70·0	
50·0		66·0	
	46·16		67·5
		𝔈—2·02 mgr.	
		61·5	
		63·5	
		61·0	
			62·0

Whence 5·5 divisions of balance No. 5=2·02 mgr., or 1 div. =0·37 mgr.

Result, 𝔖=𝔈—400·3 mgr. —10·6 div., or 3·92 mgr.
∴ 𝔖=𝔈—404·22.

Appendix XX.—*continued.*

The mean results of these weighings in air of 𝕾 and 𝕮 are as follows:—

No.	Weighings in Air.	t. Centigr.	b. at 0° C.	Weight of Air displaced by			Result in a Vacuum.
				𝕾 + 0·4 grm. of Platinum.	𝕮.	Excess by 𝕾.	
	mgr.	°	mm.	mgr.	mgr.	mgr.	grammes.
(1)	𝕾≏𝕮−403·84	10·91	765·72	471·43	59·13	412·30	𝕾=𝕮+0·00046
(2)	𝕾≏𝕮−404·42	10·47	765·85	472·27	59·24	413·03	𝕾=𝕮+0·00086
(3)	𝕾≏𝕮−404·22	11·60	768·54	471·85	59·19	412·66	𝕾=𝕮+0·00844
				Mean - - - - -			𝕾=𝕮+0·00850
	Weight of 𝕮 in terms of 𝕬 (kilogramme des Archives) - - - =						999·99844
	Weight of 𝕾 in terms of 𝕬 (kilogramme des Archives) - - - =						1000·00694
	In standard air 𝕾 displaces - - - - - - 0·45932 grm. of air.						
	In standard air, the commercial standard kilogram 𝕶 displaces - 0·14623 „						
	Deduct excess by 𝕾 - - - - - - -						0·21309
	Weight of 𝕾 in standard air, in terms of the commercial metric brass or bronze standard -						999·69401

As this determination of the weight of 𝕾 is more than 7 mgr. (1000·00694 — 999·99973) in excess of that of Steinheil, it seemed requisite to make further comparisons of 𝕾, both with the platinum kilogram 𝕮, and with the gilt brass kilogram 𝕶𝕭, which was verified at Paris. The following further comparison of 𝕾 with 𝕮 was made by myself:—

23 February 1871, mean t.=14°·28 C., b.=770·77 mm.

𝕾+398 mgr. of platinum.	𝕮
43·75	61·5
43·75	61·2
43·75	61·75
—— 43·43	—— 61·483

𝕮—1·01 mgr.
59
59
59
— 59

Whence 2·483 div. of balance No. 5 = 1·02, or 1 div. = 0·407 mgr.

Result, 𝕾 ≏ 𝕮—398·28 mgr.—8·86 div. or 3·61 mgr.
∴ 𝕾=𝕮—401·89 mgr.

𝕾+401 mgr. of platinum displaces 468·67 mgr. of air, and 𝕮 58·79 mgr., whence in a vacuum, 𝕾=𝕮+7·99 mgr.; whence 𝕾=𝕬+6·43 mgr., or 1000·00643 mgr.

The Comparisons of 𝕾 with 𝕶𝕭 were as follows:—

Comparisons of 𝕾 with 𝕶𝕭.

(1.) 1871. Feb. 22. t.=14·44° C. b.=772·65 mm.

𝕾+309·63 mgr. of platinum.	𝕶𝕭
52·5	58·5
57·0	59·5
0·56	59·0
—— 55·16	—— 59·0

𝕶𝕭—5·05 mgr.
49·75
49·50
53·50
—— 50·916

Hence 8·083 div. of balance No. 5 =5·05 mgr., or 1 div. =0·62 mgr.

Result, 𝕾≏𝕶𝕭—309·63 mgr., 1·91 div., or 1·19 mgr.
∴ 𝕾=𝕶𝕭—310·82.

(2.) Feb. 23. t.=12·61° C. b.=771·72 mm.

𝕾+311·78 mgr. of platinum.	𝕶𝕭
48·5	55·75
55·5	58·00
56·0	56·50
—— 53·3	—— 56·75

𝕶𝕭—5·05 mgr.
45·75
46·90
46·50
—— 46·383

Hence 10·367 div. of balance No. 5 = 5·05 mgr., or 1 div. = 0·487 mgr.

Result, 𝕾≏𝕶𝕭—311·78 mgr. — 1·71 div., or 0·83 mgr.
∴ 𝕾=𝕶𝕭—312·61.

Reductions of Comparisons.

No.	Weighings in Air.	t. Centigr.	b.	Weight of Air displaced by			Result in a Vacuum.
				𝕾−0·3 grm. of Brass.	𝕶𝕭.	Excess by 𝕾.	
	mgr.	°	mm.	mgr.	mgr.	mgr.	
(1)	𝕾≏𝕶𝕭−310·82	14·44	772·65	469·60	155·99	313·61	𝕾=𝕶𝕭+2·79
(2)	𝕾≏𝕶𝕭−312·61	12·61	771·72	472·22	157·21	315·01	𝕾=𝕶𝕭+2·40
				Mean - - - - -			𝕾=𝕶𝕭+2·64
	𝕶𝕭 = kilogr. des Archives - - - - - -						+4·13
	∴ 𝕾 = kilogr. des Archives - - - - - -						+6·77

Appendix XX.—*continued.*

The results of these three comparisons tend altogether to confirm the accuracy of the preceding comparisons of 𝕾 with 𝕰, and to show that the true weight of 𝕾 is about 6·80 mgr. in excess.

Invariableness of quartz weights shown by Steinheil.

The difference of this result with Steinheil's determination is not so readily accounted for. It is quite improbable that 𝕾 can have varied in weight since it was compared by Steinheil. In his paper of 1867 before referred to, he says:—

> "A standard weight of rock crystal may be considered as for ever invariable under ordinary circumstances. This body is so hard that it can be rubbed as often and as much as you like without risk of wearing. It can be placed in water, alcohol, oil, and quicksilver, as well as in all acids, with one exception, without being in the least affected. Protection is only required from injury by mechanical force or heat. In selecting its form all sharp angled corners are consequently to be avoided, as these are more liable to injury."

In order to show the invariableness of a quartz standard weight, Steinheil gives the following results of the comparisons of two quartz half kilograms, V^1 and 5^1, in 1846–7 and in 1867:—

Comparisons in 1846–7.

		mgr.
Mean result of	4 direct comparisons in 1846	$V^1 = 5^1 + 3·503$
„	2 further ditto - - -	+3·542
„	10 similar comparisons in 1847 - - - -	+3·431
„	10 further comparisons, adding on both sides a combination of other smaller accurately verified quartz weights, from 500 grams. to 1 gramme - -	+3·410
	Mean result of all -	+3·452

Comparisons in 1867.

Mean result of first 12 observations, with a doubtfully adjusted balance - -	+3·394
„ 14·5 further comparisons after adjustment of balance and thorough washing of the crystal - -	+3·455
Corrected mean of all these comparisons in 1867 -	+3·431
Mean result of all the comparisons in 1846–7 and 1867 - - - - - - - - -	+3·440
Difference between the mean results of 1846–7 and 1867 - - - - - - - - -	+0·021

Steinheil observes that these comparisons show no change in the two crystal weights, exceeding $\frac{1}{100}$ mgr., and that so far they appear to be constant and invariable.

With respect to the effect of variation of temperature and barometric pressure, he adds, that a variation of 1 Paris line (2·256 mm.) in the barometer causes a variation in the difference between the weight in air of a platinum and a quartz kilogram of 1·2 mgr. (or 0·53 mgr. for 1 mm.); and a variation in the temperature of 1° C. causes a similar relative difference in weight of 1·4 mgr.

Report by Austrian Commission in 1870 on crystal kilogram $\odot^k$.

It will have been seen that the value of 𝕾 has been expressed by Steinheil in terms of his crystal kilogram $\odot^k$. This kilogram was transferred to the Austrian Government, and is intended to constitute the primary standard of weight on the contemplated establishment of the metric system in Austria.

As before shown, the weight in a vacuum of $\odot^k$ was determined by Steinheil to be 0·15 mgr. in excess of the Kilogramme des Archives. But this determination was arrived at through a comparison with the crystal kilogram B^k, the weight of which had been ascertained by comparison with the Kilogramme des Archives at Paris in 1837. It was, however, observed by the scientific authorities at Vienna that since 1837 more accurate determinations of the weight of air had been generally accepted, and that Steinheil had made no allowance in his reductions of these crystal kilograms for moisture in the air. On these grounds a Commission was appointed by the Austrian Government to make new reductions of Steinheil's weighings, and, if considered necessary, to make further comparisons of $\odot^k$. This Commission consisted of the following members:—

Dr. Joseph Herr, Professor of Geodesy and Astronomy at the Imperial Polytechnic Institute;
Dr. A. R. von Schrötter, General Secretary of the Imperial Academy of Sciences, and Director of the Imperial Mint;
Dr. V. Pierre, Professor of Physics at the Imperial Polytechnic Institute;
G. Starke, Principal of the Astronomical Laboratory;
C. Rumler, Director of the Standards Office at Vienna.

The Commission were also instructed to ascertain and determine the equivalents in terms of the metric system of the existing legal standard weights of Austria.

The report of the Commission was printed at Vienna in 1870, and contains 140 pages 4to. It is entitled, "Ueber "das Verhältniss des Bergkrystall Kilogrammes, welches "bei Einführung des Metrischen Maasses und Gewichtes "das Urgewicht in Oesterreich bilden soll, zum Kilo-"gramme der Archive zu Paris; und über das Verhältniss "der in der Oesterreichisch-Ungarischen Monarchie gegen-"wärtig gesetzlich bestehenden Gewicht zum metrischen "Gewichte."

The following is a summary of this report:—

Weight of Atmospheric Air.—Regnault's latest determination of the weight of a litre of dry air at Paris, *t.* =0° C., *b.* =760 mm. (as corrected by Lasch), is taken =0·001293204 grm.; the average amount of carbonic acid contained in it =0·0004 of its volume; the density of carbonic acid =1·529084; whence the weight of a litre of such dry air holding carbonic acid =0·001293478 grm. In like manner, the weight of such air at Munich, lat. 48° 8′, and height above sea level, 525 m., was taken =0·001293279 grm.

Expansion of Air.—Regnault's determination of the coefficient of the expansion of air for 1° C., was taken =0·0036706.

Density of the Platinum Kilogramme des Archives (𝕬).—Steinheil took the mean volume of 𝕬 as determined from the several observations of Olufsen in 1835, and Gambey and himself in 1837, viz.:—*v.* 𝕬=48·6533 cc., whence Δ 𝕬 at 0° C.=20·548. This value is dependent on the determination of the density of the Danish platinum kilogram taken as 21·2047.

Professor Miller's correction of this value is next mentioned, who made Δ 𝕬=20·5487, from taking Schumacher's later determination of the density of the Danish kilogram =21·2037. From his own observations of the volume of 𝕬 by means of the stereometer, and from his determination of the density of the English platinum kilogram 𝕰=21·13791, together with the results of its weighings with 𝕬, Professor Miller is stated by the Commission to have found *v.* 𝕬=751·197 grains of water at 4° C., or 48·6768 cc., and consequently Δ 𝕬=20·5437.

The Commission next refer to M. Silbermann's report in 1852, who found, by measurement of 𝕬 with Gambey's comparateur, *v.* 𝕬=48·6973 cc., and to the report of a French Commission of the Conservatoire des Arts et Metiers in 1864, who found *v.* 𝕬=48·7597 cc. They also refer to the determination of Δ 𝕬 at Paris in 1869, from the measurements made by M. Yvon Villarceau, during the comparisons of the Prussian platinum kilogram, the density of which =20·0257, whence *v.* 𝕬=48·7139 cc., and Δ 𝕬=20·5291. But the Commission incline to Herr Brix's opinion that the measurement was faulty from no pressure having been used, and that the value would be more correctly expressed as *v.* 𝕬=48·6724 cc., Δ 𝕬=20·5466.

Under all these circumstances, the Austrian Commission considered that the most accurate determination would be the mean between the results obtained from Gambey's comparateur and the stereometer, and took *v.* 𝕬=48·6741 cc., Δ 𝕬=20·5448.

Coefficient of linear expansion of Platinum.—Instead of Borda's value for 1° C. taken by Steinheil, viz. 0·0000035655, the Commission preferred to take Schumacher's value =0·00000900.

Density and coefficient of linear expansion of Quartz.—The Commission, after examining in great detail the weighings and reductions made by Steinheil, and applying the several corrections according to their judgment, came to the following results:—

—	Quartz.	
	Density.	Expansion for 1° C.
Steinheil's determination - - -	2·650962	0·00001085
Corrected by the Commission - -	2·651262	0·00001561

Appendix XX.—*continued.*

Their corrected weight of $\odot^k$.

Standard weight of B^k *and* $\odot^k$.—In like manner, after an examination of the weighings of B^k with $\mathfrak{A}$, and of $\odot^k$ with B^k, and their reductions as made by Steinheil, the Commission come to the following result:—

——	Steinheil's Determination.			Corrected by the Commission.		
	grm.		mgr.	grm.		mgr.
Weight of B^k - - - - -	1000·01411	±	0·05	1000·012069	±	0·210
$\odot^k = B^k$ - - - -	— 0·01426	±	0·02	— 0·014265	±	0·213
Weight of $\odot^k$ - - - - -	999·99985	±	0·04	999·997804	±	0·202

Weight of $\odot^k$ *as compared with the Vienna Platinum Kilogram* Z.—The platinum kilogram Z was compared at Paris in 1857 with the platinum kilogramme of the Conservatoire des Arts et Metiers, and its weight in terms of the Kilogramme des Archives definitively found to be - - - - - - - - grm. 999·998833

The result of numerous comparisons made at Vienna in 1868, and their reductions showed $\odot^k$=Z — 0·000904

Whence $\odot^k$ =999·997929

The Commission, however, preferred to take the value of $\odot^k$, as more nearly derived from $\mathfrak{A}$ through B^k and =999·997804 grm.; and consequently to correct the value of Z - - - - - - - - =999·998708

Austrian standard weights and their metric equivalents.

In the second part of their report, the Austrian Commission describe the legal Austrian standard weights and state their equivalents in metric weight.

The Austrian standard of weight for coin is the Vienna mark constructed in 1767. It is made of brass in the form of a truncated pyramid with a knob screwed on. From a series of comparisons made in 1868 with the Vienna platinum kilogram Z, the standard mark was found to weigh in a vacuum 280·6683 grm.

The Vienna pound was the standard of Austrian weights up to the end of the 15th century, when the half-pound was introduced for Mint purposes, and became, under the name of "Mark," the standard throughout Germany for weighings of gold and silver. The Vienna pound of that period was equal to 562·746 grm., and consequently the Vienna mark=281·373 grams. By an edict of the Emperor Charles V., in 1524, the Cologne mark was constituted the standard for mint purposes in Germany. Its weight was nearly 234 grams.*

In 1560, by an edict of the Emperor Ferdinand I., the Vienna mark, based upon the Cologne mark, five Vienna marks being declared to be equal to six Cologne marks, was constituted the standard weight for coin in Austria.

The weight of the Austrian standard mark of 1767 was determined upon its original construction from the mean of six Cologne marks obtained from Augsburg, and verified with the mint standard there. The latest determination of the weight of the Vienna mark makes, therefore, the Cologne mark =233·890 grm.

The gilt brass Vienna pound is the standard weight for commercial purposes. The gilt brass standard constructed in 1756 was found from the relative weight of the Vienna mark in 1868, to weigh 560·060 grm. in a vacuum. There is also a standard centner of the same date, which in like manner has been declared to weigh 56006·114 grm. The intermediate standard weights are of 2, 3, 4, 5, 6, 8, 10, 25, 50 lbs.

The standard medicinal weight in Austria is the gilt brass apothecaries pound, which is ¾ of the Vienna pound, and consequently weighs 420·045 grm. in a vacuum.

Remarks Report of Austrian Commissi

With respect to this Report of the Austrian Commission, it is to be observed:

1. That there appears to be some misapprehension at to Professor Miller's acceptance of his determination of the volume and density of $\mathfrak{A}$ from the stereometer observations and its weighings with $\mathfrak{C}$. The volume of $v.\,\mathfrak{A}$ as thus determined, viz., $v.\,\mathfrak{A}-v.\,\mathfrak{C}=21\cdot119$, or 751·197 grains of water of maximum density (Miller, p. 881), was rejected by Professor Miller in favour of the previous measurements of the linear dimension of $\mathfrak{A}$, and its weighing with Schumacher's platinum kilogram. From these, and the weighings of $\mathfrak{C}$ with $\mathfrak{A}$, he considered $v.\,\mathfrak{A}=751\cdot014$ (730·081+20·933, see pp. 882 and 890), whence $v.\,\mathfrak{A}=48\cdot6712$ cc., and $\Delta\,\mathfrak{A}=20\cdot5460$.

Volume density Kilogran des Archives.

2. With respect to the actual density of $\mathfrak{A}$, it has been already stated by Professor Miller (p. 875) that $\mathfrak{A}$ had never been weighed in water previous to its first adjustment, and that it has since been considered too hazardous to immerse it in water, from its being supposed to be not entirely free from an admixture of arsenic, which on being wetted, might oxidise and dissolve, and thus produce a very sensible alteration of weight. Only an approximate value of its volume and density has consequently been found by linear measurement and weighing with other kilograms, the density of which has been accurately determined. The discordances in these approximate determinations are shown in the report of the Austrian Commission.

It is thus evident that doubt still exists as to the actual volume and density of this primary standard weight of the metric system, and that consequently some discordances in the weight of other kilograms, as determined from comparisons with it at different times, can hardly fail to arise.

3. The corrected coefficient of linear expansion of crystal, for 1° C. at 18° C.=0·00001561 does not correspond so nearly with M. Fizeau's determination (See p. 243), viz., $\frac{0\cdot00003470}{3}=0\cdot00001156$, as Steinheil's determination of 0·00001085.

How sta weight affected this Rep

4. If the corrected weight of $\odot^k$ be accepted, the result will be that a still greater discordance will arise in the relative weight of $\mathfrak{S}$, as determined by Steinheil and by the Standards Department. Thus,

——	From Steinheil's Weighings.	From Weighings of Standards Department.
	mgr.	
Austrian Commission - - -	$\odot^k = \mathfrak{A} - 2\cdot196$	
Steinheil - - - - - -	$\mathfrak{S} = \odot^k - 0\cdot119$	
∴	$\mathfrak{S} = \mathfrak{A} - 2\cdot315$	
		mgr.
Miller - - - - - - -	- - -	$\mathfrak{C} = \mathfrak{A} - 1\cdot560$
Standards Department - - -	- - -	$\mathfrak{S} = \mathfrak{C} + 8\cdot500$
	∴	$\mathfrak{S} = \mathfrak{A} + 6\cdot940$

Showing a discordance in the relative weight of $\mathfrak{S}$ amounting to more than 9 mgr.

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* There are two specimens of the Cologne mark amongst the standard money weights deposited in the Standards Office, and transferred from the Mint. Of these, the Cologne mark sent from Hamburgh was found by Dr. Kelly (Cambist, vol. i., p. 71) to weigh 3,608 English grains, equal to 233·795 grams.

The Cologne mark was somewhat lighter than the ancient standard weight of France, the *Poids de Marc* of Charlemagne, which was determined by the French Commission in 1798 to be equal to 244 753 grams (or 3,777 English grains). The French mark, like the German, was the half of the livre or pound.

Appendix XX.—*continued.*

Under these circumstances, I propose to communicate further with Messrs. Steinheil at Munich, and with Professor Voit, who was engaged with Steinheil in making the weighing and reduction of 𝕾, with a view of attempting to reconcile all these discordances. I propose also to make some further weighings of 𝕾 with 𝕮 in the new vacuum balance, when it shall have been completed for departmental use. The final determination of the standard weight of 𝕾 must however be deferred until the absolute density of the primary standard weight of the metric system shall have been determined by the International Metric Commission at Paris.

𝕾 unit of weight for glass Metric weights.

Taking the true weight of 𝕾, as determined above, to be 1000·00680 grm., and it having been shown that in standard air ($t.=62°$ F., $b.=30$ inches,) the commercial standard kilogram 𝕶 displaces 146·23 mgr. of air, whilst 𝕾 displaces 459·32 mgr., being an excess by 𝕾 of 313·09 mgr., and the true weight of 𝕶 being 1000·01034, it follows that in standard air, 𝕾=𝕶+316·63 mgr., and the unit of weight for brass or bronze commercial metric weights being 𝕶−10·34 mgr., the unit of weight for glass commercial metric weights should be 𝕾+306·29 mgr.

Verification of Glass Metric Weights, Series 𝕻.

Description of Salleron's glass Metric weights adjusted with mercury.

Amongst the collection of standard weights deposited in the Standards Department, which are specified in Appendix XVIII., are two sets of metric weights, from a kilogram to a gramme, made by Salleron, of Paris, of opaque glass, adjusted with mercury and hermetically sealed. They are intended to be of the density of brass weights, and are of cylindrical form, with a knob. The mercury is introduced through a minute vertical hole in the knob, of the size of a small needle, which is afterwards closed by fusing. Each complete set of 13 weights (including duplicates of 100, 10, and 2 grammes), is fitted in a mahogany box, together with the 13 flat platinum smaller weights, from 1 gramme to 1 milligram. The cost at Paris is 125 frs. One of these sets, distinguished as 𝕻 No. 1, has been verified in the Standards Department, and the density of the two weights of a kilogram and 500 grm. has been determined as follows :—

Determination of Density of Glass Metric Weights
1 *kilo.*, 500 *grm.*, *and* 100 *grm.* 𝕻 *No.* 1.

Determination of their density.

1870, Nov. 14.	grm.
1 kilog., 𝕻 No. 1, assumed weight in air ($t=12·77°$ C, $b.=741·768$ mm.) - -	=1000·00000
1 kilog., 𝕻 No. 1, weighed in water against brass metric weights, ($t.$ of water 11·55°C.)	= 879·89003
	120·10997
Add weight of water displaced by 879·89003 grm. of brass - - -	+ 0·12833
	120·23830

Log. weight of water displaced -	2·0800424
Add log. W_t - - - - -	0·0001775
	2·0802199
Deduct log. $(1+e\ G_t)$ - -	0·0001327
log. V. 1 kilog. 𝕻 No. 1	2·0800872
Deduct from log. weight in air of 1 kilog., 𝕻 No. 1 - -	3·0000000
log. Δ 1 kilog. 𝕻 No. 1	0·9199128, or Δ=8·3160

In a similar process Δ 500 grm. 𝕻 No. 1=8·1894.

The density of these glass weights loaded with mercury is thus shown to approximate sufficiently near to the average density of brass or bronze weights.

The verification of the complete set, 𝕻 No. 1, including the small platinum weights, has been effected as follows :—

Comparison of Glass Metric Weights 𝕻 No. 1.

Their actual comparisons.

No.	Date of Comparison.		Compared Standard.	Comparing Standard.	Balance used.	Value of one Division of Balance.	Difference of compared Standard.	
							In Div.	In Mgr.
	1870.		𝕻 No. 1. Glass adjusted with mercury.			mgr.	div.	mgr.
(1)	Dec.	20	1 kilog. + 1^1 cg. 𝕭	≏ Gilt brass kilo. 𝕶	No. 5.	0·441	− 6·1	−2·690
(2)	”	22	1 kilog.	≏ Brass kilo. 𝕸	”	0·695	+ 2·1	+1·485
			grm.	grm. 𝕸.				
(3)	”	21	500 + 1^1 cg. 𝕭	≏ 500	”	0·420	− 7·2	−3·024
(4)	”	”	200 + 1m 𝕭	≏ 200	No. 3.	0·063	−17·9	−1·142
	1871.							
(5)	Jan.	19	100	≏ 100^1	”	0·126	+ 6·8	+0·868
(6)	”	”	100^1	≏ 100	”	0·099	+14·5	+1·445
(7)	”	21	50	≏ 50 + 2 m. + 1^1 m. 𝕭	”	0·096	+ 5·4	+0·527
(8)	”	”	20	≏ 20	”	0·139	+ 5·0	+0·702
(9)	”	23	10	≏ 10	”	0·114	− 2·7	−0·331
(10)	”	”	10^1	≏ 10^1	”	0·106	− 3·8	−0·413
(11)	”	”	5	≏ 5	No. 4.	0·028	+ 7·0	+0·248
(12)	”	”	2	≏ 2	”	0·039	+ 5·9	+0·233
(13)	”	24	2^1	≏ 2	”	0·036	+ 6·1	+0·222
(14)	”	”	1	≏ 1^1	”	0·039	− 7·3	−0·285
(15)	”	25	500, 200, 100, 100^1, 50, 20, 10, 10^1, 5, 2^1, 1.	≏ 500, 200, 100, 100^1, 50, 20, 10, 10^1, 5, 2, 1^1 + 1c 𝕭.	No. 5.	0·361	− 6·0	−2·166
			Platinum. grm.	Platinum. grm. 𝕬.				
(16)	”	24	1	≏ 1	No. 4.	0·037	− 4·6	−0·173
(17)	”	”	0·5	≏ 0·5	”	0·037	− 4·1	−0·156
(18)	”	”	0·2	≏ 0·2	”	0·038	+ 3·7	+0·145
(19)	”	”	0·1	≏ 0·1	”	0·037	+ 1·5	+0·056
(20)	”	”	$0·1^1$	≏ $0·1^1$	”	0·039	− 1·8	−0·072
(21)	”	”	0·05	≏ 0·05	No. 6.	0·013	−10·2	−0·140
(22)	”	”	0·02	≏ 0·02	”	0·012	+ 7·7	+0·098
(23)	”	”	0·01	≏ 0·01	”	0·013	− 5·2	−0·068
(24)	”	”	$0·01^1$	≏ $0·01^1$	”	0·012	− 1·5	−0·019
(25)	”	”	0·005	≏ 0·005	”	0·013	+ 3·2	+0·042
(26)	”	25	$0·002^1$	≏ 0·002	”	0·013	−12·1	−0·159
(27)	”	”	0·002	≏ 0·002	”	0·013	− 4·1	−0·054
(28)	”	”	0·001	≏ 0·001	”	0·013	−10·6	−0·140
(29)	”	”	0·5 to 0·001	≏ 0·5 to 0·001	No. 4.	0·034	+14·7	+0·510

Appendix XX.—*continued.*

Results of Comparisons.

No.	Compared Standard.		Comparing Standard.	Difference of compared Standard.	Error of comparing Standard. $t=62°$, $b.=30$.	Error of compared Standard.	Exact Weight of compared Standard. $t.=62°$, $b.=30$.
	𝔓 No. 1.						
	grm.		grm.	grm.	grm.	grm.	grm.
(1)	1000	=	1000 𝔎	−0·01307	+0·01043	−0·00264	999·99736
(2)	1000	=	1000 𝔐	−0·00148	+0·00187	+0·00039	1000·00039
(3)	500	=	500	−0·01340	−0·00340	−0·01680	499·98320
(4)	200	=	200	−0·00230	+0·00085	−0·00145	199·99855
(5)	100	=	100^1	+0·00087	−0·00043	+0·00044	100·00044
(6)	100^1	=	100	+0·00144	−0·00058	+0·00086	100·00086
(7)	50	=	50	+0·00388	−0·00292	+0·00096	50·00096
(8)	20	=	20	+0·00070	+0·00005	+0·00075	20·00075
(9)	10	=	10	−0·00033	+0·00070	+0·00037	10·00037
(10)	10^1	=	10^1	−0·00041	+0·00041	—	10·00000
(11)	5	=	5	+0·00020	−0·00046	−0·00026	4·99974
(12)	2	=	2	+0·00023	+0·00001	+0·00024	2·00024
(13)	2^1	=	2	+0·00022	+0·00001	+0·00023	2·00023
(14)	1	=	1^1	−0·00028	+0·00022	−0·00006	0·99994
(15)	500 to 1	=	500 to 1 𝔐	−0·00797	−0·00565	−0·01362	997·98638
				From (3) to (11) and (13) (14) - 500 to 1 𝔖 =			997·98504
					Difference - - - -		0·00134
	Platinum Weights.						
	grm.		grm.	mgr.	mgr.	mgr.	mgr.
(16)	1	=	1 𝔐	−0·17	+0·22	+0·05	1000·05
(17)	0·5	=	0·5 𝔄	−0·15	+0·10	−0·05	499·95
(18)	0·2	=	0·2	+0·14	−0·18	−0·04	199·96
(19)	0·1	=	0·1	+0·05	−0·25	−0·20	99·80
(20)	$0·1^1$	=	$0·1^1$	−0·07	+0·10	+0·03	100·03
(21)	0·05	=	0·05	−0·14	+0·03	−0·11	49·89
(22)	0·02	=	0·02	+0·10	−0·11	−0·01	19·99
(23)	0·01	=	0·01	−0·07	+0·06	−0·01	9·99
(24)	$0·01^1$	=	$0·01^1$	−0·02	+0·23	+0·21	10·21
(25)	0·005	=	0·005	+0·04	+0·05	+0·09	5·09
(26)	$0·002^1$	=	0·002	−0·16	+0·15	−0·01	1·99
(27)	0·002	=	0·002	−0·05	+0·15	+0·10	2·10
(28)	0·001	=	0·001	−0·14	−0·05	−0·19	0·81
(29)	0·5 to 0·001	=	0·5 to 0·001 𝔄	+0·51	+0·13	+0·64	998·64
				By (17) − (27) - - - - - - =			999·00
					Difference - - - -		0·36

PART 3.—VERIFICATION OF NEW STANDARD COIN WEIGHTS.

CONTENTS.

	Page
Question of multiple coin weights required - - - - - - -	248
None but those specified in Coinage Act, 1870, now needed - - - - -	249
Construction of new Standard coin weights - - - - - - -	„
Their verification - - - - - - - - - - -	„
New balance, No. 6 - - - - - - - - - -	„
Density of coin weights - - - - - - - - -	„
Determination of their densities - - - - - - - -	„
Actual comparisons of Standard coin weights - - - - - - -	251
Reductions of weighings of Standard gold coin weights - - - - -	253
Results of these comparisons - - - - - - - - -	„

Question of multiple coin weights required.

Since Part IV. of Appendix V. (p. 76) was laid before the Commission, the question has again been brought under their consideration whether any series of Standard weights, being multiples of the sovereign of either the full legal weight or the least current weight, is actually required. The result of inquiries made showed that multiple weights of the sovereign were used by bankers only; that they were never used for determining the weight of any number of gold coins, but merely for checking the number. The multiple weights, so used, were made either of brass or of glass, and were constructed of neither the full legal weight nor the least current weight, but of a mean between the two. Thus, whilst the legal full weight of 100 sovereigns is 12327·447 grains, and the least current weight 12250 grains, and the mean weight 12288·7235 grains, it was customary to make the bankers multiple weight of 100 sovereigns equal to 12289 grains, which was considered to be the average weight of sovereigns in circulation.

Appendix XX.—*continued.*

None but those specified in Coinage Act, 1870, now needed.

Under these circumstances and considering that, although the subject was brought under the notice of the Committee of London Bankers, no request was made by them for legalising Standard weights of multiples of the sovereign for their use, the Commission determined at their meeting of 9th April last, that in their opinion no multiples of the sovereign weight are required beyond those specified in the schedule to the Coinage Act, and that the former recommendation of the Commission in their First Report for legalising a decimal series of gold coin weights of the full legal weight must now be abandoned.

Construction of new Standard coin weights.

The mode of construction of the twenty new Standard coin weights specified in the Coinage Act, 1870, having been approved by the Commission at the meeting of 9th April (see Minutes, s. 7), the order for constructing them was given to Mr. Oertling on 12th April. Three complete sets were ordered, to be fitted in three separate boxes.

The first set, being the Standards for reference, consisted of the following weights :—

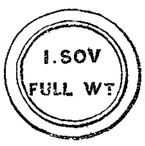
	Of what metal composed.	Marked.
Gold coin weights :—		
Five sovereigns	Gilt gun-metal	5 sov., full wt.
Two sovereigns		2 sov., full wt.
Sovereign -	Standard gold	1 sov., full wt.
Half sovereign		½ sov., full wt.
Five sovereigns	Gilt gun-metal	5 sov., least wt.
Two sovereigns		2 sov., least wt.
Sovereign -	Standard gold	1 sov., least wt.
Half sovereign		½ sov., least wt.
Silver coin weights :		
Crown - -	Alloy of palladium and silver.	Crown.
Half crown -		½ crown.
Florin - -		Florin.
Shilling - -		1*s.*
Sixpence - -		6*d.*
Groat, or fourpence - -		4*d.*
Threepence -		3*d.*
Twopence -		2*d.*
Penny - -		1*d.*
Bronze coin weights :		
Penny - -	Same as bronze coinage.	Penny.
Halfpenny -		½*d.*
Farthing - -		¼*d.*

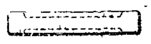
The second set, being the official standard coin weights, are similarly marked, but with the addition of the letter O to distinguish them.

The official gold coin Standards are of gilt gun-metal.
„ silver „ „ Baily's metal.
„ bronze „ „ bronze coinage metal.

The third set are counterpoises, each weight similarly marked, but with the addition of the letter C. The gold and silver coin counterpoise weights are of Baily's metal, and the bronze weights of bronze coinage metal.

The coin weights all of a flat cylindrical shape, the height being about one-third of the diameter. On the upper surface there is a raised rim, and the central part for the engraving is a little depressed, thus :—





The boxes for these weights are of mahogany, and each weight fits into a shallow cylindrical hole in an ivory slab, having its designation with the Imperial weight in grains, and the Metric weight in grammes, engraved around it. The top of the box is of plate glass, so that each weight is distinctly seen.

Verification of new Standard coin weights.

The new Standard coin weights were delivered at the Standards Office on 23rd June, and their verification was at once proceeded with. For weighing the larger coin weights, balance No. 4 was used, being the smallest of the four balances provided for the decimal bullion weights.

New balance No. 6.

For weighing the smaller coin weights, the new balance for grain weights has been used. This balance has been recently constructed by Mr. Oertling, under the sanction of the Commission at the meeting of 14th May, (see Minutes, s. 8), and was delivered at the Department on July 2. The beam is 10 inches long, and is of an improved construction, on a stand with double columns. It is made to carry 30 grains in each pan and to turn with less than $\frac{1}{1000}$ of a grain. The beam is graduated, and there is the usual contrivance for placing sliding weights upon it without opening the glass case which encloses the balance. The pans for holding the weights are of silver, in the form of small flat cups, and are moveable; they rest upon small saucers of silver, suspended by two platinum wires.

Density of coin weights.

In the verification of these Standard coin weights, it has been necessary to take into consideration the difference of their densities, so far as regards those made of standard gold and of the alloy of palladium and silver.

The density of gold is stated to be about 19·3. Professor Graham (Elem. of Chem., vol. ii., p. 349) says, that it varies from 19·258 to 19·367, according as the metal has been more or less compressed. The density of the platinum of which the Imperial standard pound is composed being 21·15, and the average density of brass or bronze weights being 8·15, it has been shown by Professor Miller that there is a difference of 0·645 grain in the weight of ordinary air (*t.* 65·66 F., *b.* 29·75) displaced by two Standard pounds of these metals. This difference would amount to 0·01133 grain in 123 grains, the standard weight of the sovereign. The difference of density of platinum and bronze being 13·0, and between gold and bronze being 11·15, it results that the difference of the weight of ordinary air displaced by a sovereign weight of gold and one of bronze is 0·00972 grain.

According to Professor Graham (p. 331) the density of pure silver varies between 10·474 and 10·542. He says of palladium (p. 385) that in external characters it closely resembles platinum. It is nearly as infusible, but can more easily be welded. The density of the fused metal is 11·3, and after being laminated 11·8. It is nearly as white as silver, and not blackened by sulphurous emanations.

The alloy of palladium and silver being of nearly equal parts of these metals, if its density be estimated at 11, the difference of the density of bronze will be 2·85. The largest silver coin weight being 436 grains, the difference of weight of ordinary air displaced by such a weight of palladium silver and one of bronze would be 0·00881 grain.

The metal of which the bronze coinage is made (Graham, p. 106) is an alloy of 100 parts of copper with 5 tin, or of 4 tin + 1 zinc.

Determination of densities of coin weights.

The following comparisons have been made for determining the density of the Standard gold, palladium silver alloy, and bronze coinage metal of which the Standard coin weights are made:

No.	Date of Comparison.	Compared Standard Coin Weights, weighed in Water.	Comparing Weights.	Result in Divisions of Balance No. 4.	Value of 1 Division.	Result in Grains.
				Div.	Gr.	Gr.
(1)	1870, July 6 -	Sovereign, full weight, of standard gold.	≏ Gilt grain weights, 100, 10, 5, 1 (or 116·99927 gr.) -	−6·25	0·02023	−0·12644
(2)	„ „ 5 -	Crown, of palladium silver -	≏ Do., 300, 50, 30, 10, 5, 1, 0·5 gr. (or 396·50285 gr.) -	+3·5	0·04046	+0·14161
(3)	„ „ 5 -	Shilling, of palladium silver -	≏ Do., 50, 20, 5, 3, 1, 0·3 gr. (or 79·30255 gr.) - -	−0·6	0·03916	−0·02350
(4)	„ „ 5 -	Penny, of coinage bronze -	≏ Do., 100, 20, 5, 3, 1 gr. (or 128·99892 gr.) - - -	+0·95	0·06744	+0·06407

Appendix XX.—*continued.*

Reduction of Weighings.

Standard gold sovereign, full weight:—

		gr.	
Weight in air, (t. 65° F., b. 30·013 in.)		=123·27430	
„ in water (t. 64·4° F.)		=116·87283	
		6·40147	
Add weight of air displaced by 116·87283 gr. of gun metal		+ 0·01655	
∴ Weight of water displaced by sovereign, full weight		6·41802	
	gr.		
Log. weight of water displaced	0·8074010		
Add log W_t	+0·0005867		
	0·8079877		
Deduct log. $1+eP_t$	—0·0003997		
Whence log V sovereign, full weight	0·8075880		
Deduct from log. weight in air, in grains	—2·0908715		
Log. Δ	1·2832835		gr.
∴ Density of Standard gold sovereign, full weight			19·199

Palladium silver, crown weight:—

Weight in air (t. and b. as before)		436·36534	
„ in water		396·64446	
		39·72088	
Add weight of air displaced by 396·64446 gr. of gun metal		+ 0·06221	
∴ Weight of water displaced by palladium silver, crown weight		39·78309	
Log. weight of water displaced	1·5996975		
Log. W_t	+0·0005867		
	1·6002842		
Log. e P_t	—0·0003997		
Whence log. V palladium silver, crown weight	1·5998845		
Log. weight in air, in grains	—2·6398400		
Log. Δ	1·0399555		
∴ Δ Palladium silver, crown weight			10·964

Palladium silver, shilling weight:—

Weight in air (t. 65°, b. 30·013 in.)		=87·27522	
„ in water (t. 64·6, b. „)		=79·27905	
		7·99617	
Add weight of air displaced by 79·27905 gr. of bronze		+ 0·01135	
∴ Weight of water displaced by palladium silver, shilling weight		8·00752	
Log. weight of water displaced	0·9034980		
Add log. W_t	+0·0005867		
	0·9040847		
Deduct log. $1+e$ P_t	—0·0003997		
Whence log. V palladium silver, shilling weight	0·9036850		
Deduct from log. weight in air, in grains	—1·9408909		
Log. Δ	1·0372059		
∴ Δ Palladium silver, shilling weight			10·895

Bronze coinage, penny weight:—

Weight in air (t. 65°, b. 30·013 in.)		145·88747	
„ in water (t. 65° „)		129·06299	
		16·82448	
Add weight of air displaced by 129·06299 gr. of bronze		+ 0·01849	
∴ Weight of water displaced by bronze penny weight		16·84297	
Log. weight of water displaced	1·2264194		
Add log. W_t	+0·0006114		
	1·2270308		
Deduct log. $1+eP_t$	—0·0004071		
Log. V bronze penny weight	1·2266237		
Deduct from log. weight in air, in grains	—2·1641068		
Log. Δ	0·9374831		
∴ Δ Bronze penny weight			8·659

Appendix XX.—*continued.*

In the following comparisons of the Standard coin weights with the Standard decimal grain weights of gilt gun metal, eight weighings have been made for each comparison :—

Actual comparison of Standard coin weights.

Comparison of Standard Coin Weights.

No.	Date. 1870.	Compared Coin Standard Weights.	Comparing Standard Weights.	Result in Divisions of Balance No. 4 (and Balance No. 6 marked *).	Value of one Division. Grain. Balance 4 and 6.	Result in Grains.
Gold Coin Standards:—						
(1)	July 5 -	Five Pound full weight -	≏Gilt gun metal grains, 500, 100, 10, 5, 1, 0·3, 0·05, 0·02 (616·37455 grs.)	+4·525	0·00081	+0·00370
(2)	„ „ -	Do. least current -	≏Gilt gun metal grains, 500, 100, 10, 2, 5 (612·50432 grs.) - - -	+1·412	0·00090	+0·00128
(3)	„ 4 -	Two Pound full weight -	≏Gilt gun metal grains, 200, 30, 10, 5, 1, 0·5, 0·05 (246·54952 grs.) - -	+0·862	0·00212	+0·00182
(4)	„ „ -	Do. least current -	≏Gilt gun metal grains, 200, 30, 10, 5 (244·99953 grs.) - - -	+1·068	0·00215	+0·00229
(5)	„ 6 -	Sovereign full weight -	≏Gilt gun metal grains, 100, 20, 3, 0·2, 0·05, 0·03 (123·27800 grs.) -	−4·468*	0·00086	−0·00384
(6)	„ „ -	Do. least current -	≏Gilt gun metal grains, 100, 20, 2, 0·5 (122·49855 grs.) - - -	+5·125*	0·00083	+0·00429
(7)	„ 8 -	Half Sovereign full weight	≏Gilt gun metal grains, 60, 1, 0·5, 0·03 (No. 1), 0·1, and 0·01 (61·63941 grs.) - - - -	−2·387*	0·00055	−0·00312
(8)	„ „ -	Do. least current	≏Gilt gun metal grains, 60, 1, 0·03, and (No. 1), 0·01 (61·12939 grs.) -	−6·312*	0·00041	−0·00262
Gold Coin Official Standards:						
(9)	July 5 -	Five Pound full weight -	≏Gilt gun metal grains, 500, 100, 10, 5, 1, 0·3, 0·05, 0·02 (616·37455 grs.) -	+1·318	0·00081	+0·00107
(10)	„ „ -	Do. least current -	≏Gilt gun metal grains, 500, 100, 10, 2, 0·5 (612·50432 grs.) - -	+0·331	0·00080	+0·00026
(11)	„ 4 -	Two Pound full weight -	≏Gilt gun metal grains, 200, 30, 10, 5, 1, 0·5, 0·05 (246·54952 grs.) - -	+0·762	0·00202	+0·00154
(12)	„ „ -	Do. least current -	≏Gilt gun metal grains, 200, 30, 10, 5 (244·99953 grs.) - - -	+0·262	0·00216	+0·00057
(13)	„ „ -	Sovereign full weight -	≏Gilt gun metal grains, 100, 20, 3, 0·2, 0·05, 0·02 (123·26802 grs.) -	+8·712	0·00085	+0·00744
(14)	„ „ -	Do. least current -	≏Gilt gun metal grains, 100, 20, 2, 0·5 (122·49855 grs.) - - -	+4·737	0·00082	+0·00390
(15)	„ 8 -	Half Sovereign full weight	≏Gilt gun metal grains, 60, 1, 0·5, 0·03, and (No.1), 0·1, 0·01 (61·63941 grs.)	−1·150*	0·00046	−0·00053
(16)	„ 4 -	Do. least current	≏Gilt gun metal grains, 60, 1, 0·03, and (No. 1), 0·01 (61·12938 grs.) -	−6·312*	0·00048	−0·00303
Gold Coin Counterpoise Weights:—						
(17)	July 5 -	Five Pound full weight -	≏Gilt gun metal grains, 500, 100, 10, 5, 1, 0·3, 0·05, 0·02 (616·37455 grs.) -	+3·062	0·00090	+0·00277
(18)	„ „ -	Do. least current -	≏Gilt gun metal grains, 500, 100, 10, 2, 0·5 (612·50432 grs.) - -	+2·656	0·00095	+0·00252
(19)	„ 4 -	Two Pound full weight -	≏Gilt gun metal grains, 200, 30, 10, 5, 1, 0·5, 0·05 (246·54952 grs.) - -	−0·437	0·00387	−0·00017
(20)	„ „ -	Do. least current -	≏Gilt gun metal grains, 200, 30, 10, 5 (244·99953 grs.) - - -	+1·518	0·00217	+0·00329
(21)	„ „ -	One Sovereign full weight	≏Gilt gun metal grains, 100, 20, 3, 0·2, 0·05, 0·02 (123·26802 grs.) -	+8·556	0·00085	+0·00729
(22)	„ „ -	Do. least current -	≏Gilt gun metal grains, 100, 20, 2, 0·5 (122·49855 grs.) - - -	+5·037	0·00084	+0·00424
(23)	„ 8 -	Half Sovereign full weight	≏Gilt gun metal grains, 60, 1, 0·5, 0·03 (No. 1), 0·1, 0·01 (61·63941 grs.) -	−0·437*	0·00048	−0·00021
(24)	„ 4 -	Do. least current -	≏Gilt gun metal grains, 60, 1, 0·05 (No. 1), 0·05, 0·03 (61·12957 grs.)	−5·775*	0·00047	−0·00274
Silver Coin Standards:—						
(25)	June 24 -	Crown - - -	≏Gilt gun metal grains, 300, 100, 30, 5, 1, 0·3, 0·05, 0·01 (436·36016 grs.)	+5·056	0·00102	+0·00518
(26)	„ 25 -	Half Crown - -	≏Gilt gun metal grains, 200, 10, 50, 2, 0·5, 0·3, 0·2, 0·1, 0·05, 0·03 (218·17984 grs.) - - -	+5·893	0·00089	+0·00529
(27)	„ 27 -	Florin - - -	≏Gilt gun metal grains, 100, 50, 20, 3, 1, 0·5, 0·05 (174·54986 grs.) - -	−0·425	0·00093	−0·00040
(28)	„ „ -	Shilling - - -	≏Gilt gun metal grains, 50, 30, 5, 2, 0·2, 0·05, 0·02 (87·27192 grs.) - -	+3·443	0·00095	+0·00330
(29)	July 2 -	Sixpence - - -	≏Gilt gun metal grains, 30, 10, 3, 0·5 (No. 1), 0·1, and 0·05 (43·64881 grs.) - - - - -	−11·925	0·00094	−0·01128
(30)	„ 4 -	Groat, or 4*d.* - -	≏Gilt gun metal grains, 20, 5, 3, 1, 0·01 (No. 1), (29·09965 grs.) - -	−4·75	0·00094	−0·00450

Appendix XX.—*continued.*

No.	Date. 1870.	Compared Coin Standard Weights.	Comparing Standard Weights.	Result in Divisions of Balance No. 4 (and Balance No. 6 marked*).	Value of one Division Grain. Balance 4 and 6.	Result in Grains.
(31)	July 5	Threepence	≏Gilt gun metal grains, 20, 1, 0·5, 0·3, 0·02 (21·81880 grs.)	+0·462	0·00093	+0·00043
(32)	„ 4	Twopence	≏Gilt gun metal grains, 10, 3, 1, 0·5, 0·03, 0·02 (No. 1), 0·01 (14·55050 grs.)	−2·468	0·00106	−0·00264
(33)	„ 5	Penny	≏Gilt gun metal grains, 5, 2, 0·2, 0·05, 0·02 (7·27060 grs.)	+1·462	0·00093	+0·00136
Silver Coin Official Standards:—						
(34)	June 25	Crown	≏Gilt gun metal grains, 300, 100, 30, 5, 1, 0·3, 0·02, 0·05 (436·36957 grs.)	−3·893	0·00091	−0·00356
(35)	„ „	Half Crown	≏Gilt gun metal grains, 200, 10, 5, 2, 0·5, 0·3, 0·2, 0·1, 0·05, 0·03 (218·17984 grs.)	+5·831	0·00093	+0·00546
(36)	„ 27	Florin	≏Gilt gun metal grains, 100, 50, 20, 3, 1, 0·5, 0·05 (174·54986 grs.)	−0·737	0·00087	−0·00064
(37)	„ „	Shilling	≏Gilt gun metal grains, 50, 30, 5, 2, 0·2, 0·05, 0·02 (87·27192 grs.)	+2·981	0·00088	+0·00265
(38)	July 2	Sixpence	≏Gilt gun metal grains, 30, 10, 3, 0·5, (No. 1), 0·1, and 0·05 (43·64881 grs.)	−12·05	0·00110	−0·01326
(39)	„	Groat, or 4*d.*	≏Gilt gun metal grains, 20, 5, 3, 1, 0·1 (29·09965 grs.)	−5·187	0·00086	−0·00449
(40)	„ 5	Threepence	≏Gilt gun metal grains, 20, 1, 0·5, 0·3, 0·02 (21·81880 grs.)	−0·906	0·00092	+0·00084
(41)	„ 4	Twopence	≏Gilt gun metal grains (No. 1), 10, 3, 1, 0·5, 0·03, 0·02 (14·55050 grs.)	−3·219	0·00092	−0·00296
(42)	„ 5	Penny	≏Gilt gun metal grains, 5, 2, 0·2, 0·05, 0·02 (7·27060 grs.)	+2·106	0·00093	+0·00197
Silver Coin Counterpoises:—						
(43)	June 25	Crown	≏Gilt gun metal grains, 300, 100, 30, 5, 1, 0·3, 0·05, 0·02 (436·36957 grs.)	−4·050	0·00098	−0·00396
(44)	„ „	Half Crown	≏Gilt gun metal grains, 200, 10, 5, 2, 0·5, 0·3, 0·2, 0·1, 0·05, 0·03 (218·17984 grs.)	+4·756	0·00083	+0·00393
(45)	„ 27	Florin	≏Gilt gun metal grains, 100, 50, 20, 3, 1, 0·5, 0·05, 0·01 (174·55982 grs.)	−11·012	0·00092	−0·01012
(46)	„ „	Shilling	≏Gilt gun metal grains, 50, 30, 5, 2, 0·2, 0·05, 0·02 (87·27192 grs.)	+3·181	0·00095	+0·00301
(47)	July 4	Sixpence	≏Gilt gun metal grains (Set No. 1), 30, 10, 3, 0·5, 0·1, 0·03 (43·63154 grs.)	+8·375	0·00092	+0·00775
(48)	„ „	Groat or 4*d.*	≏Gilt gun metal grains (Set No. 1), 20, 5, 3, 1, 0·1 (29·09965 grs.)	−5·562	0·00105	−0·00583
(49)	„ „	Threepence	≏Gilt gun metal grains, 20, 1, 0·5, 0·3, 0·02 (21·8188 grs.)	+0·625	0·00093	+0·00058
(50)	„ „	Twopence	≏Gilt gun metal grains, 10, 3, 1, 0·5, 0·05 (14·54908 grs.)	−1·594	0·00033 0·00092	+0·00022 −0·00147
(51)	„ 5	Penny	≏Gilt gun metal grains, 5, 2, 0·2, 0·05, 0·02 (7·27060 grs.)	+1·362	0·00096	+0·00130
Bronze Coin Standards:—						
(52)	June 28	Penny	≏Gilt gun metal grains, 100, 30, 10, 5, 0·5, 0·2, 0·1, 0·05, 0·03 (145·87885 grs.)	+9·319	0·00092	+0·00862
(53)	„ „	Halfpenny	≏Gilt gun metal grains, 50, 30, 5, 2, 0·5 (87·50219 grs.)	+2·750	0·00093	+0·00257
(54)	July 2	Farthing	≏Gilt gun metal grains, 30, 10, 3, 0·5, 0·2, 0·05 (43·74926 grs.)	+1·744	0·00105	+0·00183
Bronze Coin Official Standards:						
(55)	June 28	Penny	≏Gilt gun metal grains, 100, 30, 10, 5, 0·5, 0·2, 0·1, 0·05, 0·03 (145·87885 grs.	+9·750	0·00093	+0·00907
(56)	„ „	Halfpenny	≏Gilt gun metal grains, 50, 30, 5, 2, 0·5 (87·50219 grs.)	+2·806	0·00092	+0·00258
(57)	July 2	Farthing	≏Gilt gun metal grains, 30, 10, 3, 0·5, 0·2, 0·05 (43·74926 grs.)	+2·887	0·00091	+0·00264
Bronze Coin Counterpoises:						
(58)	June 28	Penny	≏Gilt gun metal grains, 100, 30, 10, 5, 0·5, 0·2, 0·1, 0·05, 0·03 (145·87885 grs.)	+7·544	0·00092	+0·00693
(59)	„ „	Halfpenny	≏Gilt gun metal grains, 50, 30, 5, 2, 0·5 (87·50219 grs.)	+2·144	0·00092	+0·00197
(60)	July 2	Farthing	≏Gilt gun metal grains, 30, 10, 3, 0·5, 0·02, 0·05 (43·74926 grs.)	+2·606	0·00090	+0·00235

Appendix XX.—*continued.*

Reduction of weighings of Standard gold coin weights.

The following reductions of the comparisons of the Standard gold coin weights of the sovereign and half sovereign have been made :—

		gr.	gr.
(5.)	Standard gold sovereign full weight, in air, *t.* 19°·61 C., *b.* 764·86$^{\text{mm}}$		=123·27416
	Weight of air displaced by gilt gun metal grain weights	0·01755	
	" " by sovereign full weight	0·00777	
	Deduct excess displaced by grain weights		— 0·00978
	Weight of sovereign full weight, in vacuum		123·26438
	Weight of standard air, *t.* 65°·66, *b.* 755·54$^{\text{mm}}$, displaced by grain weights	0·01740	
	" " " by sovereign full weight	0·00770	
	Add excess displaced by grain weights		+ 0·00970
	∴ Weight in standard air of sovereign full weight		123·27408
(6.)	Standard gold sovereign least weight, in air, *t.* 19°·61, *b.* 764·86$^{\text{mm}}$		=122·50284
	Weight of air displaced by grain weights	0·01748	
	" " by sovereign least weight	0·00772	
	Deduct excess displaced by grain weights		— 0·00976
	Weight of sovereign least weight, in vacuum		122·49308
	Weight of standard air, *t.* 65°·66, *b.* 755·54$^{\text{mm}}$, displaced by grain weights	0·01733	
	" " " by sovereign least weight	0·00765	
	Add excess displaced by grain weights		+ 0·00968
	∴ Weight in standard air of sovereign least weight		122·50276
(7.)	Standard gold half sovereign full weight, in air, *t.* 19°·4, *b.* 761·25$^{\text{mm}}$		= 61·63809
	Weight of air displaced by grain weights	0·00873	
	" " by half sovereign full weight	0·00386	
	Deduct excess displaced by grain weights		— 0·00487
	Weight of half sovereign full weight, in vacuum		61·63322
	Weight of standard air displaced by grain weights	0·00869	
	" " by half sovereign least weight	0·00384	
	Add excess displaced by grain weights		+ 0·00485
	∴ Weight in standard air of half sovereign full weight		61·63807
(8.)	Standard gold half sovereign least weight, in air, *t.* 19°·61, *b.* 764·86$^{\text{mm}}$		= 61·12677
	Weight of air displaced by grain weights	0·00870	
	" " by half sovereign least weight	0·00385	
	Deduct excess displaced by grain weights		— 0·00485
	Weight of half sovereign least weight, in vacuum		61·12192
	Weight of standard air displaced by grain weights	0·00866	
	" " by half sovereign least weight	0·00383	
	Add excess displaced by grain weights		+ 0·00483
	∴ Weight in standard air of half sovereign least weight		61·12675

No reduction for difference of density in the weighings of the palladium silver coin weights and of the bronze coinage weights with the gilt gun metal weights appear to be requisite.

Results of comparisons of Standard coin weights.

The following table shows the results of the comparisons of all the Standard coin weights, both in Imperial grains and in Metric grammes; the latter being computed according to the Table of Equivalents appended to the Second Report of the Commission.

Results of Comparisons of Standard Coin Weights.

—			Ascertained Weight.		Ascertained Error.	
			Grains.	Grammes.	Grains.	Grammes.
Gold Coin Standards :—						
(1)	Five Pound,	full weight	=616·37825	39·940663	+0·00586	+0·000380
(2)	do.	least current	=612·50560	39·689719	+0·00560	+0·000363
(3)	Two Pound,	full weight	=246·55134	15·976268	+0·00239	+0·000151
(4)	do.	least current	=245·00182	15·875861	+0·00182	+0·000118
(5)	Sovereign,	full weight	=123·27408	7·988031	−0·00039	−0·000026
(6)	do.	least current	=122·50276	7·938050	+0·00276	+0·000179
(7)	Half Sovereign,	full weight	= 61·63807	3·994082	+0·00084	+0·000055
(8)	do.	least current	= 61·12675	3·960949	+0·00175	+0·000114
Gold Coin Official Standards :—						
(9)	Five Pound,	full weight	=616·37562	39·940493	+0·00323	+0·000209
(10)	do.	least current	=612·50458	39·689654	+0·00458	+0·000297
(11)	Two Pound,	full weight	=246·55106	15·976250	+0·00211	+0·000136
(12)	do.	least current	=245·00009	15·875748	+0·00009	+0·000006

Appendix XX.—*continued.*

Results of Comparisons of Standard Coin Weights—continued.

—	Ascertained Weight.		Ascertained Error.	
	Grains.	Grammes.	Grains.	Grammes.
(13) Sovereign, full weight - - -	=123·27546	7·988120	+0·00099	+0·000066
(14) do. least current - - -	=122·50245	7·938030	+0·00245	+0·000159
(15) Half Sovereign, full weight - - -	= 61·63888	3·994135	+0·00165	+0·000107
(16) do. least current - - -	= 61·12635	3·960923	+0·00135	+0·000087
Gold Coin Counterpoise Weights:—				
(17) Five Pound, full weight - - -	=616·37732	39·940603	+0·00493	+0·000319
(18) do. least current - - -	=612·50684	39·689800	+0·00684	+0·000443
(19) Two Pound, full weight - - -	=246·54935	15·976139	+0·00040	+0·000026
(20) do. least current - - -	=245·00282	15·876925	+0·00282	+0·000183
(21) Sovereign, full weight - - -	=123·27531	7·988111	+0·00084	+0·000054
(22) do. least current - - -	=122·50279	7·938052	+0·00279	+0·000181
(23) Half Sovereign, full weight - - -	= 61·63920	3·994155	+0·00197	+0·000128
(24) do. least current - - -	= 61·12683	3·960954	+0·00183	+0·000118
Silver Coin Standards:—				
(25) Crown - - - - - - -	=436·36534	28·276016	+0·00171	+0·000111
(26) Half Crown - - - - - -	=218·18513	14·138167	+0·00332	+0·000215
(27) Florin - - - - - - -	=174·54946	11·310622	+0·00401	+0·000260
(28) Shilling - - - - - - -	= 87·27522	5·655343	+0·00250	+0·000162
(29) Sixpence - - - - - -	= 43·63753	2·827666	+0·00117	+0·000076
(30) Groat, or Fourpence - - - - -	= 29·09515	1·885335	+0·00425	+0·000275
(31) Threepence - - - - - -	= 21·81923	1·413863	+0·00105	+0·000068
(32) Twopence - - - - - -	= 14·54786	0·942686	+0·00241	+0·000156
(33) Penny - - - - - - -	= 7·27196	0·471215	−0·00076	−0·000049
Silver Coin Official Standards:—				
(34) Crown - - - - - - -	=436·36601	28·276059	+0·00238	+0·000154
(35) Half Crown - - - - - -	=218·18530	14·138178	+0·00349	+0·000226
(36) Florin - - - - - - -	=174·54922	11·310606	+0·00377	+0·000244
(37) Shilling - - - - - - -	= 87·27457	5·655300	+0·00185	+0·000120
(38) Sixpence - - - - - -	= 43·63555	2·827538	−0·00081	−0·000052
(39) Groat, or Fourpence - - - - -	= 29·09516	1·885336	+0·00426	+0·000276
(40) Threepence - - - - - -	= 21·81964	1·413890	+0·00146	+0·000095
(41) Twopence - - - - - -	= 14·54754	0·942665	+0·00209	+0·000135
(42) Penny - - - - - - -	= 7·27257	0·471255	−0·00015	−0·000010
Silver Coin Counterpoise Weights:—				
(43) Crown - - - - - - -	=436·36561	28·276033	+0·00198	+0·000128
(44) Half Crown - - - - - -	=218·18377	14·138079	+0·00196	+0·000127
(45) Florin - - - - - - -	=174·54970	11·310637	+0·00425	+0·000275
(46) Shilling - - - - - - -	= 87·27493	5·655324	+0·00221	+0·000143
(47) Sixpence - - - - - -	= 43·63929	2·827780	+0·00293	+0·000190
(48) Fourpence - - - - - -	= 29·09382	1·885249	+0·00292	+0·000189
(49) Threepence - - - - - -	= 21·81938	1·413873	+0·00120	+0·000078
(50) Twopence - - - - - -	= 14·54761	0·942670	+0·00216	+0·000140
(51) Penny - - - - - - -	= 7·27190	0·471211	−0·00082	−0·000053
Bronze Coin Standards:—				
(52) Penny - - - - - - -	=145·83747	9·450115	+0·00414	+0·002683
(53) Halfpenny - - - - - -	= 87·50476	5·670216	+0·00476	+0·000308
(54) Farthing - - - - - -	= 43·75109	2·835025	+0·00109	+0·000058
Bronze Coin Official Standards:—				
(55) Penny - - - - - - -	=145·83792	9·450141	+0·00459	+0·002974
(56) Halfpenny - - - - - -	= 87·50477	5·670217	+0·00477	+0·000310
(57) Farthing - - - - - -	= 43·75189	2·835076	+0·00189	+0·000122
Bronze Coin Counterpoise Weights:—				
(58) Penny - - - - - - -	=145·83578	9·450005	+0·00245	+0·001587
(59) Halfpenny - - - - - -	= 87·50416	5·670177	+0·00416	+0·000269
(60) Farthing - - - - - -	= 43·75161	2·835058	+0·00161	+0·000104

H. W. CHISHOLM,
Warden.

Standards Department, 12th July 1870.

PART 4.—Verification of Standard Test Gas Meters.

Contents.

	Page
Description of new standard test gas meters	255
Measurement of gas or air by test meters	"
Mode of verification of new standard test meters	"
Importance of maintaining a uniform temperature and pressure of the gas or air measured	256
Relative advantages as to form, &c. of wet and dry test meters	"
Nominal measuring capacity, or rate of speed of gas meters	"
Results of experiments with wet and dry meters at different rates of speed	"
Verification of new standard test gas meters	"
20-light test dry meter	"
100-light test dry meter	258
20-light test wet meter	260
100 " "	261
Summary of results of verification of test meters	262
Comparisons of standard test gas meters with each other	263
Actual comparisons	"
Their results	265
Table of corrections for testing a large with a small wet meter	"
Further comparisons to be made with commercial wet and dry meters	"

Verification of Standard Test Gas Meters.

Description of new standard test gas meters.

The new Standard test gas meters, which have been recently furnished for the use of the Standards Department, have already been described in Part 2 of Appendix VIII., and in which the objects of their construction and proposed legalisation as standards have been fully stated. They are four in number, viz.:—

Constructed by Messrs. G. Glover & Co.

A 20-light Standard test dry meter, to pass 0·5 cubic foot at each revolution or complete action.

A 100-light Standard test dry meter, to pass 2·5 cubic feet at each revolution or complete action.

Constructed by Messrs. A. Wright & Co.

A 20-light Standard test wet meter, to pass 1 cubic foot at each revolution or complete action.

A 100-light Standard test wet meter, to pass 5 cubic feet at each revolution or complete action.

They are intended to serve as standards by which copies may be officially verified for the use of local inspectors of gas meters in testing large commercial gas meters, that cannot without serious inconvenience be removed to the testing office, and for the testing of which by the ordinary local gas measuring standard or gasholder there are obvious difficulties and impediments.

The methods by which gas or air is measured in ordinary commercial gas meters is sufficiently explained in Appendix VI., 4th Report, p. 304, Appendix VIII., 5th Report, p. 143.

Measurement of gas or air by test meters.

By reference to the explanatory statements and specifications of the construction of the official standard test meters (5th Report, Appendix VIII., Mr. Hartley, pp. 139–141, Mr. G. Glover, pp. 142–145), it will be seen that gas is measured by test meters in the same manner as by ordinary meters with the following exceptions:—1. The wet test meters have not the ordinary float for limiting the error of the meter to 3 per cent. against the buyer, and 2 per cent. against the seller as required by the Sale of Gas Act, 1859.

2. The index hands of both the wet and dry test meters are connected directly with the measuring parts of the meters, so that the registration of the meter is in no way affected by the friction of the system of wheels required to work the indices of commercial meters.

The dial of the small dry meter indicates 0·5 cubic foot divided into $\frac{1}{50}$ foot. That of the large dry meter indicates 2·5 cubic feet, divided into 100 parts. The dial of the small wet meter indicates 1 cubic foot divided into $\frac{1}{100}$ foot. That of the large wet meter indicates 5 cubic feet divided into $\frac{1}{100}$ foot. The wet meter has a convenient auxiliary registering apparatus connected with a series of dials indicating respectively, 1000, 100, 10, and 1 cubic feet.

With reference to the material of which the measuring parts of a dry test meter are composed, attention may be directed to Mr. Glover's letter, Appendix VIII., p. 146, by which it would appear that the measurement of the dry test meter constructed by his firm is not affected by the elasticity or impermeability of the leather used in connecting the diaphragms of a dry meter. This Department has not yet had the means of testing this allegation, the results of the comparisons hitherto made showing only that the errors of the dry meters continue nearly constant at ordinary temperatures and hygrometric pressures. But it should be noticed that before making any definite comparisons with the new dry test meters, it was found necessary to work them for at least 10 minutes, their first registrations being generally more than 1 per cent. slow. Attention may also be drawn to the experiments with the 20-light dry meter (p. 263), showing that the registration of this meter was seriously affected by passing through it air saturated with moisture. It is, however, obvious that a considerable time must elapse before it can be satisfactorily determined whether any alteration in the substance or form of the leather composing the diaphragms of the dry test meters may have taken place, so as to affect injuriously their registration.

Mode of verification of new standard test meters.

The four official standard test meters have been compared with the official gas-measuring standards of 10 cubic feet and 5 cubic feet, according to the methods of comparison laid down in the Sale of Gas Act; and by other methods which later experience has suggested. The verification of these gas-measuring standards is stated in Appendix VIII. to the Fifth Report of the Commission, from which it will be seen that no verification of the individual feet, or parts of the scale, on these standards has ever been made. Consequently in these testings, each cubic foot, as well as each part of a foot on these scales, has been assumed as correct until its error is ascertained.

Before the errors of the new test meters were finally determined as hereafter shown, a great number of preliminary comparisons were made, particularly with the wet meters in adjusting their water line.

By the Sale of Gas Act (§ XIII.), it is required that a meter should be tested for soundness and leakage under a 3-inch pressure, the duration of the test to be estimated by a light or lights consuming not more than $\frac{1}{20}$ part of its measuring capacity per hour marked thereon, nor less than ½ cubic foot per hour, for all meters of a measuring capacity not exceeding 100 cubic feet per hour, or $\frac{1}{40}$ part of its measuring capacity per hour for all larger meters. The meter is then to be tested for error at a pressure of ½ inch, and passing the quantity per hour marked on it, when placed on a horizontal base, all temperatures being, as far as practicable, uniform.

The method by which these test meters have now been tested is shown in the official directions for verifying local standard gas measures (Appendix VIII., 5th Report, p. 136); excepting §§ 3, 4, 7, 13, of these directions.

With the view of testing the mechanism of the meter previously to employing the tests for leakage and correct measurement, it was ascertained that the wet meter could always be adjusted to a definite horizontal plane; that the registering apparatus was properly constructed and not liable to displacement; that the meter worked at a pressure as low as 0·2 inch; that the diaphragms and valves of the dry meter worked easily and securely, the flow of gas through the meter being continuous.

It may be here observed that the amount of driving force required to pass gas through the meter varies according to the density of the gas passed and the height of the barometer. Thus on 17th January, a driving force amounting to $\frac{6}{10}$ inch of a column of water was required to work the 20-light meter at a certain rate, the barometer being then at 29·00 inch; but on the following day, when the barometer stood at 29·10, it was found that a driving force of $\frac{7}{10}$ inch, or an extra $\frac{1}{10}$ inch, was necessary to keep the meter in action at the same rate. The exact difference of driving force required can of course be determined by the difference of density of water and mercury; but some difference also results from variation of friction.

It was intended that the meters should be tested at various rates of speed up to five and six times their nominal measuring capacities, and the error at each speed separately stated, but owing to the narrow diameter of the outlet pipes of the standard gasholders, it was found quite impossible to test these meters completely, and consequently their final verifications at higher rates of speed must be delayed until larger pipes shall have been furnished.

The important determination of the speed of the meter under comparison was made by timing the fall of the

Appendix XX.—*continued.*

"bell" of the comparing gas-measuring standard by means of a very correct seconds pendulum constructed by Pennington, by which fractions of a second could be appreciated.

Importance of maintaining a uniform temperature and density of the gas or air measured.

To ensure accuracy in meter testing, it is very necessary to bear in mind that the temperature and the density of the gas which is being passed through the compared meter should remain the same as when it was measured in the comparing standard gasholder, or that when practicable the proper correction should be applied. It is, however, very difficult to pass gas or air from a gasholder through a meter so that it remains of the same density at the outlet of the comparing standard and at the inlet and outlet of the meter.

Owing to the small diameter of the pipes connecting the meters with the standard gasholders during these official operations, it was found necessary to apply the due correction to the results first obtained. The density of the air measured in the comparing standard gasholder was determined by the pressure gauge on the top of the gasholder to be equal to a mean pressure of 2 inches of a column of water; but when this air reached the inlet of the meter, its density was, in a similar manner, determined to be equal to only 0·9 inch of a column of water; thus showing a loss of density, or of volume, of the air measured by the meter equal to 1·1 inch of a column of water.

Bunsen (Gasometry, page 285) gives the respective equivalents of 2 inches and 0·9 inch of a column of water to be 0·14 inch and 0·06 inch of a column of mercury.

Now the normal height of the barometer for gas measurement being 30 inches, the density of the air, measured as above in the standard gasholder, will consequently be 30·14 in., and that in the meter 30·06 in., and as the volume of gas is inversely as its pressure, it is evident that if the standard at a pressure of 30·14 in. measured 10 cubic feet, the meter should register, at a pressure of 30·06 inch, 10·026 cubic feet; and therefore that 0·026 cubic feet must be deducted from the meter registration.

Relative advantage as to form, &c. of wet and dry test meters.

Before describing the process of verification and determination of the error of each meter, it may be desirable to consider the circumstances under which either wet or dry test meters will be used by the inspectors.

Large commercial meters which are to be verified by comparison with test meters are usually fixed in the basements and passages of buildings, and are seldom convenient of access; the weight and size of the testing meter becomes, therefore, a matter of importance.

The forms, sizes, and weights of the several new standard test meters have already been stated at pp. 141, 142, and 145, Appendix VIII.

As occupying less space in depth from back to front, the dry meter appears to be better adapted for use in narrow passages and basements of buildings.

The two official standard wet test meters were estimated to cost 65*l.* and 25*l.* respectively, exclusive of their fittings, but they actually cost 78*l.* and 35*l.*; the estimated and the actual cost of the two dry test meters was respectively 20*l.* and 6*l.* 6*s.* The wet meters are, however, very highly finished and substantial instruments; Mr. Hartley, the manager of Messrs. Wright and Co., manufacturers, having taken the greatest care in constructing them in the very best manner.

Nominal measuring capacity of meters.

Every gas meter is constructed to pass a certain quantity of gas per hour, which quantity is termed its nominal measuring capacity, although it will if necessary pass a much larger quantity per hour, or work at higher speeds. This method of construction is required in commercial meters where the demand upon the work of a meter is variable and uncertain, and it is also required in the standard test meters, which will generally be required to test meters having much greater measuring capacity than the test meter itself. It is therefore of the highest importance that the test meter should register correctly when gas is passed through it at a greater rate than its nominal measuring capacity per hour.

Results of experiments with meters at different rates of speed.

The results of experiments made for the purpose have tended to show that the dry test meter, when thus worked at high speeds, registers more correctly than the wet test meter, *with a fixed water line*, similarly worked beyond its nominal measuring capacity per hour.

A nearer approach to standard accuracy may however be obtained by a standard wet test meter by precise adjustment of its water line to any fixed speed per hour; but this constant adjustment of the water line for each different speed will probably be found practicable only in official operations with the standard test gas meters. The trouble and loss of time to an inspector in having first to ascertain the rate at which his test gas meter is intended to be worked, and then to adjust its water line from time to time in order to secure correct measurement, would be considerable, and would in all probability be seldom or never incurred.

Our departmental experience tends to show that neither the wet meter nor the dry meter can be depended upon within 1·0 per cent. when used under varying circumstances by the inspectors. That is to say, that although the standard test wet meter at one fixed speed will give results which will not vary so much as 0·05 per cent., yet when tried at various speeds, such as those at which it is likely to be used, it has been found to vary over 1 per cent. The dry meter also will give results on one day which will not vary among themselves more than 0·1 per cent.; *but when compared on subsequent days, the results may be found to differ over 1 per cent. from those of the first day.* For this reason, it is prop[illegible] it the allowance of error to 0·5 per cent. wh[illegible]ts are taken.

It wou[illegible] the wet meter is the most reliable i[illegible] consequence of [illegible]rect registration at a [illegible] water line. But for the general use of inspectors, when only approximate accuracy is required, the dry meter may be considered the most convenient instrument, as its mean error at various speeds is not so great as that of the wet meter, and its use requires fewer precautions to be taken to ensure due accuracy. The results of the experiments stated at p. 257 show also that a dry meter cannot be accurately tested by comparison with a wet meter, when the gas or air is first passed through the wet meter, and then into the dry meter.

Verification of new standard test gas meters.

The following are the details of the process of verifying the two new standard test dry meters for 20 lights and 100 lights, and the two wet meters of similar nominal value:—

Comparison of Test Meters with Standard Gasholders.

20-*Light Test Dry Meter.*

Verification of 20-light test dry meter.

No.	Date.	Comparing Standard.	Description of Meter compared.	Quantity passed through compared Meter, as shown on comparing Standard Scales.		Reading of Index of compared Meter.	Rate per Hour.	t., Faht.	b.
	1871.			cubic feet.	Mean.	cubic feet.		°	in.
(1)	Jan. 14	10-feet gasholder.	20-light (dry) test meter.	5·028		5 (or 10 complete actions).	50 feet, or 100 revolutions per hour.	49·0	30·0
(2)				5·016		5	"	"	"
(3)				5·023		5	"	"	"
					5·022				
(4)	" 15	"	"	5·003		5	"	46·5	29·4
(5)				5·007		5	"	"	"
					5·005				
(6)	" 18	"	"	4·998		5	"	48·5	29·0
(7)				4·990		5	"	"	"
					4·994				

Appendix XX.—*continued.*

20-Light Test Dry Meter—continued.

No.	Date.	Comparing Standard.	Description of Meter compared.	Quantity passed through compared Meter, as shown on comparing Standard Scales.		Readings of Index of compared Meter.	Rate per Hour.	t, Faht.	b.
	1871.			cubic feet.	Mean.	cubic feet.			in.
(8)	Jan. 14	10-feet gasholder.	20-light (dry) test meter.	5·022		5 (or 10 complete actions).	100 feet, or 200 revolutions per hour.	49·0	30·0
(9)				5·014		5	"	"	"
					5·018				
(10)	" 15	"	"	5·017		5	"	46·5	29·9
(11)				5·003		5	"	"	"
					5·010				
(12)	" 17	"	"	5·012		5	"	48·5	29·0
(13)				4·993		5	"		
(14)				5·010		5	"		
(15)				5·006		5	"		
(16)				5·007		5	"		
(17)				4·993		5	"		
					5·004				
(18)	" 18	"	"	4·997		5	"	50·0	29·10
(19)				4·983		5	"		
(20)				4·999		5	"		
(21)				4·988		5	"		
					4·991				
(22)	" 15	"	"	5·003		5	150 feet, or 300 revolutions per hour.	46·5	29·4
(23)				[illegible]		5	"		
					5·003				
(24)	" 17	"	"	9·980		10 (or 20 complete actions).	150 feet, or 300 revolutions per hour.	48·5	29·0
(25)				9·980		10	"		
					9·980				
(26)	" 15	"	"	5·001		5 (or 10 complete actions).	200 feet, or 400 revolutions per hour.	46·5	29·4
(27)				4·983		5	"		
					4·992				
(28)	" 18	"	"	5·001		5	"	50·0	29·10
(29)				4·969		5	"		
(30)				5·001		5	"		
(31)				4·979		5	"		
					4·987				
(32)	" "	"	"	4·980		5	250 feet, or 500 revolutions per hour.	50·0 air and water.	29·1
(33)				4·973		5	"		
					4·977				
(34)	" "	"	"	4·990		5	300 feet, or 600 revolutions per hour.		
(35)				4·982		5	"		
(36)				4·980		5	"		
(37)				4·960		5	"		
(38)				4·939		5	"		
					4·972				
(39)	Feb. 3	5-feet Standard.	"	5·013		5	100 feet, or 200 revolutions per hour.	53·0 water 54·0 air.	29·8
(40)				5·014		5	"		
(41)				5·030		5	"		
					5·019				

Appendix XX.—*continued.*

Results of Comparisons of 20-Light Test Dry Meter.

Results of comparisons of 20-light test dry meter.

No. of Comparison.	Rate per Hour.		Mean Quantity passed through compared Meter.	Reading of compared Meter Index.	Reading of compared Meter Index when 100 cubic Feet are passed through.	Error per cent. of compared Meter.
	No. of Revolutions.	Cubic Feet.				
			cubic feet.	cubic feet.	cubic feet.	
(1)–(3)	100	50	5·022	5	99·56	0·44 slow.
(4)–(5)	100	50	5·005	5	99·90	0·10 „
(6)–(7)	100	50	4·994	5	100·12	0·12 fast.
					99·86	0·14 slow, mean.
(8)–(9)	200	100	5·018	5	99·64	0·36 slow.
(10)–(11)	200	100	5·010	5	99·80	0·20 „
(12)–(17)	200	100	5·004	5	99·92	0·08 „
(18)–(21)	200	100	4·991	5	100·19	0·19 fast.
(39)–(41)	200	100	5·019	5	99·62	0·38 slow.
					99·84	0·16 slow, mean.
(22)–(23)	300	150	5·003	5	99·94	0·06 slow.
(24)–(25)	300	150	9·980	10	100·20	0·20 fast.
					100·07	0·07 fast, mean.
(26)–(27)	400	200	4·995	5	100·10	0·10 fast.
(28)–(31)	400	200	4·987	5	100·26	0·26 „
					100·18	0·18 fast, mean.
(32)–(33)	500	250	4·977	5	100·46	0·46 fast.
(34)–(38)	600	300	4·972	5	100·56	0·56 fast.

100-Light Test Dry Meter.

Verification of 100-light test dry meter.

No.	Date.	Comparing Standard.	Description of Meter compared.	Quantity passed through compared Meter, as shown on comparing Standard Scales.		Reading of Index of compared Meter.	Rate per Hour.	t, Fahr.	b.
	[illegible]			cubic feet.	Mean.	cubic feet.			in.
(1)	Jan. 20	10-feet gasholder.	100-light dry meter.	10·05[illegible]		10	250 feet, or 100 revolutions per hour.	52° air 55° water.	[illegible]
(2)				10·079		10	„	„	„
(3)				10·052		10	„		
(4)				10·073		10	„		
					10·065				
(5)	„ 21	„	„	10·110		10	„	55° air and water.	[illegible]
(6)				10·112		10	„		
(7)				10·110		10			
(8)				10·110		10	„		
					10·110				
(9)	„ [illegible]	„	„	10·078		10	350 feet, or 140 revolutions per hour.	55° air and water.	[illegible]
(10)				10·0[illegible]		10	„		
(11)				10·080		10	„		
					10·078				

Appendix XX.—*continued.*

100-*Light Test Dry Meter*—continued.

No.	Date.	Comparing Standard.	Description of Meter compared.	Quantity passed through compared Meter, as shown on comparing Standard Scales.		Reading of Index of compared Meter.	Rate per Hour.	t., Fahr.	b.
	1871.			cubic feet.	Mean.	cubic feet.		°	in.
(12)	Jan. 21	10-feet gasholder.	100-light dry meter.	10·05[illegible]		10	350 feet, or 140 revolutions per hour.	52° air and water.	29·7
(13)				10·080		10	,,	,,	,,
(14)				10·062		10	,,		
					10·064				
(15)	Feb. 4	,,	,,	10·041		Four complete actions.	250 feet, or 100 revolutions per hour.	64° air 63° water.	29·7
(16)				10·043			,,		
(17)				10·040			,,		
(18)				10·040			,,		
(19)				10·036			,,		
(20)				10·039			,,		
					10·040				
(21)	,,	,,	,,	10·039		,,	350 feet, or 140 revolutions per hour.	64° air 63° water.	29·7
(22)				10·080			,,		
(23)				10·110			,,		
					10·076				
(24)	,,	,,	,,	10·200		,,	250 feet, or 100 revolutions per hour.	,,	,,
(25)				10·200			,,		
(26)				10·200			,,		
					10·200				

Results of Comparisons, 100-*Light Test Dry Meter.*

Results comparis of 100-lig test dry meter.

No. of Comparisons.	Rate per Hour.		Mean Quantity passed through compared Meter.	Actual Reading of compared Meter Index.	Reading of compared Meter Index if 100 Feet were passed through.	Error per cent. of compared Meter.
	No. of Revolutions.	Cubic Feet.				
			cubic feet.	cubic feet.	cubic feet.	
(1)-(4)	100	250	10·065	10	99·35	0·65 slow.
(5)-(8)	100	250	10·110	10	98·90	1·10 ,,
(15)-(20)	100	250	10·040	10	99·60	0·40 ,,
(24)-(26)	100	250	10·200	10	98·00	2·00 ,,
					99·45	0·55 slow, mean error at rate of 250 ft. or 100 revolutions per hour.
(9)-(11)	140	350	10·078	10	99·22	0·78 slow.
(12)-(14)	140	350	10·064	10	99·36	0·64 ,,
(21)-(23)	140	350	10·075	10	99·24	0·76 ,,
					99·34	0·66 slow, mean error at rate of 350 ft. or 140 revolutions per hour.

Appendix XX.—*continued.*

Comparisons of 20-Light Test Wet Meter.

Verification of 20-light test wet meter.

No.	Date.	Comparing Standard.	Compared Meter.	Quantity passed through compared Meter as shown on Standard Scales.		Reading of Index of compared Meter.	Rate per Hour.	t.	B.
	1871.			cubic ft.	Mean.	cubic ft.		[illegible]	in.
(1)	Jan. 11	5-feet gasholder.	20-light wet meter, at standard water-line.	5·005		5	At the rate of 100 feet or 100 revolutions.	61	30·
(2)				5·004	5·004	5			
(3)	„ 21	„	„	5·005	5·005	5	200 feet per hour.	56	30·0
(4)	Feb. 2	„	„	5·005		5	100 feet or 100 revolutions.	61	„
(5)				5·007		5	„		
(6)				5·005		5	„		
(7)				5·007	5·006	5	„		
(8)	„ 2	„	20-light wet meter.	5·000		5	200 feet or 200 per hour.	„	„
(9)				5·000	5·000	5	„		
(10)	„ 3	„	„	5·002		5	100 feet per hour.	64	29·8
(11)				5·001		5	„		
(12)				5·000		5	„		
(13)				5·004	5·003	5	„		
(14)	„ 10	10-feet gasholder.	„	9·998		10	200 feet or 200 revolutions.	58	29·
(15)				9·998		10	„		
(16)				10·002	9·998	10	„		
(17)	„	„	„	10·050		10	300 feet or 300 revolutions per hour.	„	„
(18)				10·044	10·047	10	„		
(19)	„	„	„	10·150		10	400 feet or 400 revolutions per hour.	„	„
(20)				10·100	10·125	10	„		
(21)	„ 14	„	„	10·00[illegible]		10	200 feet or 200 revolutions per hour.	19° air 18° water.	30·1[illegible]
(22)				10·006		10	„		
(23)				10·000	10·004	10	„		
(24)	„	„	„	10·036		10	300 feet or 300 revolutions per hour.	„	
(25)				10·040	10·038	10	„		
(26)	„	„	„	10·123		10	400 feet or 400 revolutions per hour.	„	
(27)				10·150	10·136	10	„		

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